Agricultural Project Planning and Analysis: A Sourcebook Second edition Edited by P

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A Sourcebook

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Spine of the Book

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This Sourcebook is the product of a Network Activity Program, coordinated by the University of Pretoria, that forms part of the Institutional University Cooperation (IUC) between the Flemish Universities of Belgium and several universities in Africa. The Network Activity Program was initiated with a workshop in Pretoria where a course outline for a post-graduate course in agricultural project planning, management, evaluation and impact analysis, was elaborated. This workshop was attended by academics from the African Universities of Pretoia, Natal, The North, Fort Hare, Zambia, Zimbabwe, Burundi, and Sokoine University of Agriculture in Tanzania, as well as respresentatives of FAO-FARMESA in Zimbabwe, the Agricultural Research Council of SA, and LIMA (an NGO involved in rural development). The Course outline was further refined by a task team before being circulated and proposals for writing envited.

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PREFACE TO SECOND EDITION:

This is the second edition of a book originally published in 2003. The sourcebook was a product of the Institutional University Co-operation (IUC) between the Flemish university of Belgium and several universities in Eastern, Central and Southern Africa. The sourcebook was developed to address the felt needs of the agricultural higher learning institutions. It is written for undergraduate and graduate students, and for development practitioners who are concerned with project planning, implementation and evaluation including impact assessment. The sourcebook is based on the notion of project cycle, with heavy emphasis on planning and evaluation. A unique feature of this sourcebook is that it addresses both the research projects and development projects geared towards broad based agricultural and rural development.

Currently the book is being used by a number of universities as a textbook, and in some international workshops on Monitoring, Evaluation and Impact Assessment as a sourcebook for reading. The feedback and comments from the users are very positive and encouraging. As we ran out of copies, it was decided to revise the first edition before printing additional copies. The revision has also provided an opportunity to incorporate some additional materials based on the recent developments. As a result while maintaining the initial structure, number of new sections were added in order to make the book 'ever green'.

In a fast moving world the business environment is rapidly changing and becoming increasingly complex and unpredictable. The new generation of managers is facing the task of creating a balance between stability necessary to allow development of strategic planning and decision process and instability that allows continuous change and adaptation to dynamic environment. Scenario planning is a tool which has been successfully used to handle the rapidly changing environment for anticipating and managing change especially the notion of uncertainty. This technique is applicable to virtually any situation in which a decision maker would like to imagine how the future might unfold. Therefore an additional chapter was included to describe the various steps involved in scenario planning; which should be considered as part of or extension of conventional strategic planning.

When dealing with Monitoring and Evaluation, in the first edition of the book much attention was paid to progress monitoring. Because of the emergence of the participatory approaches and processes, in the recent past a distinction has been made between process monitoring and progress monitoring. Conventional progress monitoring focuses on physical, financial and logistical aspects of projects whereas process monitoring deals with critical processes which are directly related to project objectives. An ideal M&E system should contain elements of both process and progress monitoring. Therefore an additional section on process monitoring is included in chapter 12 to take care of this deficiency

The three basic issues that need to be taken care of, in any empirical impact study of R&D investment are causality, attribution and incrementality. The attribution problem is a difficult one to deal with, and it arises when one believes, or tries to claim that program has resulted in certain outcomes and alternative plausible explanation exist. A number of strategies can be used to address the attribution issue which are collectively called 'contribution analysis'. Therefore, a section covering contribution analysis is included in chapter 21, Strategies for Impact Assessment.

In the first edition of the sourcebook much emphasis was placed on projects an program planning and evaluation; where no attention was paid to the evaluation of organizations. In the recent past, organizations have become more and more complex and especially the R&D organizations are undergoing rapid and frequent changes especially in Sub-Saharan Africa. This has lead to the need for organizational performance assessment. Organizations provide the context in which virtually all work behaviour occurs, as such can be viewed as a major element of the environment affecting work behaviour, individual performance as well as goal attainment. Evaluators are often asked to assess the organizations as part of the overall evaluation process. This field is fast developing. Therefore a new chapter is included to over the methods and approaches used in organizational performance assessment.

In the revised edition we still tried to maintain the original structure of the sourcebook. Part I deals with methods and approaches for the planning and analysis of agricultural projects. The three important aspects of project management namely the management of money flows, procurements and managing of materials, and human resources management are also discussed in this section. Cost-benefit analysis methodology is discussed as an approach to appraise and evaluate projects.

Part II includes five chapters dealing with strategic planning and priority setting. As a result of declining funding, and emerging alternative funding mechanisms (especially competitive funding) to support agricultural research, the issue of planning and priority setting has become much more relevant today then ever before. In dealing with planning and priority setting due consideration is given to both agricultural research projects and development oriented projects; supply led approaches and participatory demand driven approaches. All three aspects project planning, program planning and strategic planning are discussed in this section, and a new chapter on scenario planning has been included.

Part III deals with the various aspects of R&D evaluation. The concepts of monitoring, evaluation and impact assessment are defined and a framework for comprehensive impact assessment of R&D projects is developed in Chapter 12. A distinction between process monitoring and progress monitoring was made, and the types of evaluations were defined in relation to project cycle. In Chapter 13 an attempt was made to differentiate evaluation research and research evaluation and the desirable attribution of a good evaluation is discussed. Topics such as overview of evaluation activities, utilization focused evaluation, participatory evaluation, evaluation as a research management tool, overview of R&D evaluation methods; management information systems (MIS), and Design considerations for an M&E system are also discussed in this selection.

In Part IV of the sourcebook, a wide array of R&D impact assessment methods (especially rate of returns estimates) are discussed, ranging from simple to complex, and from data hungry to qualitative methods. This part of the sourcebook confines discussions to ex-post impact assessment methods. Chapter 21 sets the context by looking at various strategies that impact on the capacity to measure and dwells on the issues of data collection. The importance of having either 'cross-sectional' or 'time-series' data is discussed here. An overview of the methods is outlined in Chapter 22.

Chapter 23 covers some of the most rigorous methods and some of the most widely used approaches for economic impact assessment. The 'economic surplus approaches' require a considerable amount of technical expertise and data. Chapters 23 and 24 cover methods that are being used to a varying degree and with different level of rigour. These include respectively the Cost saving method, the Index Number method and the Production Function approach.

The last three Chapters in this Part discuss important issues which are often of interest to those decision makers who sponsor research and its impact assessment. The issue of spill-overs is discussed in Chapter 25 and the main point here is the recognition that R&D's impact often go beyond intended physical, economic and technological boundaries. The issue of research impacts on the environment is today such an obvious hot topic and this is covered in Chapter 26. Once again the issue of participation is covered in Chapter 27. Increasingly policymakers and donors are also very much concerned about organizational performance. The issues and approaches for organization Performance Assessment are addressed in Chapter 28.

The reader is reminded that donors, financiers and beneficiary stakeholders are ultimately interested in ex-post impact of their investments. The reader may not have all the technical expertise for each method discussed, but the important things is to be familiar, and to remember that most of the time the application of such methods requires a team of people and data and that it is the point at which people with requisite expertise are recruited for the task. In addition, the importance of topical issues as the environment and participation are still paramount whatever methods are used.

Part V of the sourcebook is a collection of other relevant topics and methods that could facilitate project planning and analysis. One challenge is assessing agricultural development projects and programs with multiple layers of objectives. Multi-Criteria Analysis as discussed in Chapter 29 can be appropriate for such need. The other situation concerns impact assessment of benefits and costs of natural resources and the environment. Chapter 34 discusses 'non-market' valuation approaches that can be useful in this situation. The Delphi Method in Chapter 32 is also a special purpose estimation approach for various situations.

The growing importance of participatory process in agricultural development is also shown in Chapter 30. This Chapter is a comprehensive collection and discussion of various participatory approaches. The reader is encouraged to treasure and periodically refer to this Chapter because it is a rare collection of what is found generally in the literature. Chapter 31 is targeted at those scientists who would like to use their trial data for purposes of assessing economic and social impacts. This Chapter discusses such simple methods that non-economists can use and in this regard the reader, if a non-economist, should take advantage to familiarize oneself with these simple but effective evaluation tools. Adoption studies are discussed in Chapter 33 and the issue of adoption is key to the understanding of how research results lead to higher productivity of farmers and eventually lead to progress through greater food security and income generation by scientists and managers.

Finally, the intention of the authors is to further field test this sourcebook and based on the comments and feedback periodically revise in order to incorporate the latest developments in the field of project planning analysis and impact assessment. In addition attempts will also be made to develop field level case studies to complement this sourcebook. Therefore, readers are encouraged to provide feedback and constructive comments for the continuous development of this sourcebook. Your inputs are very much appreciated.

Editors

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PART I GUIDELINES FOR THE PLANNING AND ECONOMIC APPRAISAL OF AGRICULTURAL DEVELOPMENT PROJECTS

'Jack and Jill went up the hill
To fetch a pail of water
Jack fell down and broke his crown
And Jill came tumbling after.

Jack could have avoided that awful lump
By seeking alternative choices
Like installing some pipe and a great big pump
And handling Jill the invoices'
(Stacer Holcomb, 1967)

Project planning and analysis is essentially a process of "seeking alternative choices" to reach an agreed upon set of objectives in the most efficient manner. The reason for "seeking alternative choices" being to avoid potential disaster if a project should fail ("fall down") and all the project participants come "tumbling after"!

The project planning analysis process followed by most development institutions (such as the World Bank), entail the following steps:

- the assessment of the proposed project in view of the agreed upon project objectives; project objectives would include financial, economic efficiency and societal considerations;
- the clear specification of project objectives and the relation of such objectives to a particular government or states' overall policy and strategies;
- the description of the project in terms of the relevant economic, social, institutional, environmental, technical and financial features and the analysis thereof;
- the analysis of alternative project proposals;
- the comparison of these various alternatives;
- the selection of the most beneficial project proposal;
- final decision-making by all major parties involved to implement the project;
- project implementation according to the agreed upon project proposal; and
- monitoring and evaluation (including impact assessment).

This section of the sourcebook will describe methods and approaches for the planning and analysis of agricultural projects. The principles and methodologies can however be applied, with certain adjustments, to other investment projects in natural resources and rural economic activities and in development programmes. Short sections on project implementation management and the policy aspects of project analysis are included in this section of this sourcebook.

THE PROJECT CONCEPT

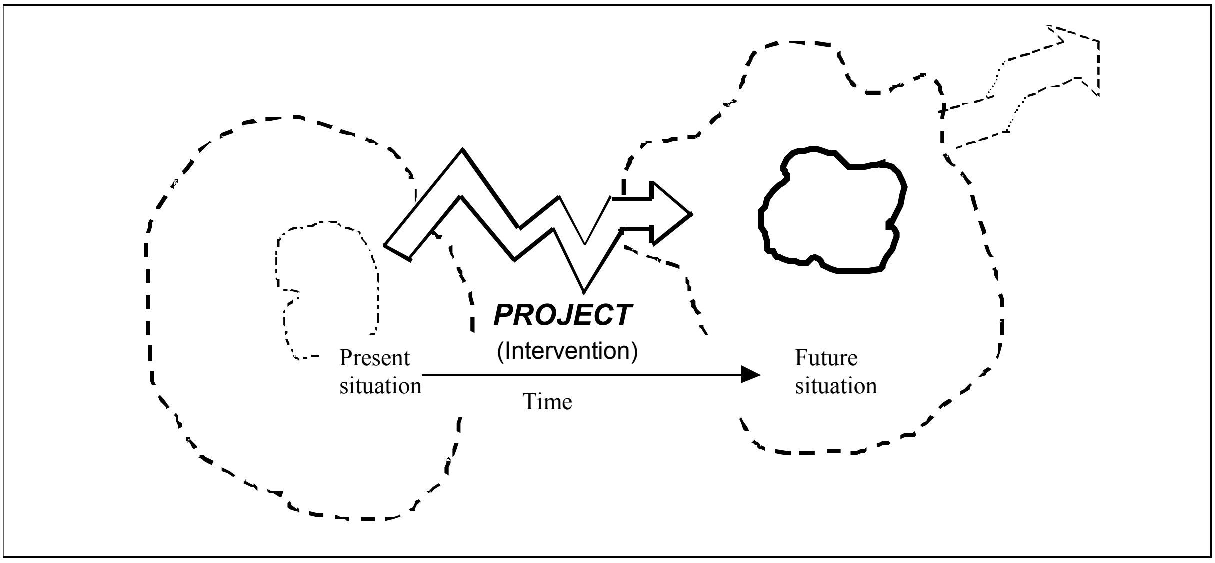
Introduction

A development project aims to change a present situation to an improved situation over time. A project is an instrument of change. Change processes have some basic common features. These include:

- the broader context in which a project is situated;
- a (problem) situation which must be changed;
- objectives, or visions of the improved future situation, that should be achieved; and
- choices about where and how to intervene through time with investments, actions and activities to achieve the envisaged improved future situation.

A project therefore represents a particular set of choices (or interventions) over time to move from a present situation to an envisaged future situation. (See Figure 1.1) The concept of development is dynamic and essentially a human phenomenon, ie. what we (the target group) want and how it is to be achieved over time.

Figure 1.1: The Project Concept



Agricultural Development Projects Defined

Agricultural development requires, among other things, an increase in profitability, productive job opportunities and greater achievement in the food and agricultural business sector. These should be accomplished with least damage, if any, to the environment.

Development projects such as those harnessing natural resources (water, land reclamation, etc), those promoting technological innovation, improved production processes, improved human capacity, social welfare, etc potentially offer an important method to achieve all three the above objectives. This type of development project is often fully or partly financed by government and development agencies and is managed as part of the national development strategy.

In this section attention is firstly given to a general definition and functional classification of development projects in the field of agricultural development. Thereafter the place and role of this type of project is contextualised within agricultural development strategy.

When defining development projects, it is important firstly to distinguish between privately financed projects and projects that form part of government (public) initiatives. In commercial agriculture, project development is largely financed privately (eg. a private, farming operation). In developing areas, project development on private initiative, however, is extremely rare and such financing is mostly linked to government or public sector funds.

Within the framework of development projects, the focus is thus largely on the flow of government funds and the possible mobilisation of private funds. Such flow of funds is therefore often regarded as the central element in many definitions of projects. The FAO, for example, refers to a development project as *"a proposal for investment where a cost stream results in a certain flow of benefits over a specified period"*.

World Bank publications expand on this idea and link project development to a flow of benefits. *"Generally, in agricultural projects we are thinking of an investment asset from which we can expect to realise benefits over an extended period of time"* (Gittinger, 1982). A project can also be viewed as a "proposal for capital investment to create opportunities for producing goods and services".

The criticism against the abovementioned definitions is that they mostly emphasise the technical aspect, ie. capital input or financial flows, which leads directly to the creation of material assets while no direct reference is made to the development functions of a project which include human development, distributional and social impacts. The contemporary view is rather that development projects are in the first place people-oriented and that provision must be made for the dynamic elements of change over time. Recent convention thus defined a development project as follows: *"A project is an instrument of change. It is a co-ordinated series of actions resulting from a decision to change resource combinations and levels so as to contribute to the realisation of the country's development objectives"*.

Such a definition focuses a project within broader development strategies and macro economic objectives and policy of a country or region. Within this defined framework it is clear that development projects do not necessarily have to focus on production. Objectives such as job creation, capital formation (savings in foreign exchange), the upliftment of a target population group, improvement of welfare for impoverished groups, the elimination of rural poverty, the redistribution of income, etc should be strived for within development planning via the project approach.

The question begging now is *"where does the project participants and more precisely the beneficiaries (farmers, agribusinesses, etc) fit into this definition?"*

One of the basic principles of economic project appraisal is that unless the individual participants benefit consistently more in the "with project" in comparison with the *"without"* project scenario, projects will fail – target groups will not participate as there are no incentives in such activities. Government also does have an important role to contribute to a *"sustained"* beneficial status, through support in the technology development system, extension, rural infrastructure investment, etc. Such support could thus be considered, especially during start up phases of projects. Government should ensure that all support be aligned with the policy objectives. However, if the long term economic and financial benefits do not exceed the costs, subsidisation, social engineering and aligned policies will not guarantee sustainability and participation.

The definition of a development project should therefore be expanded to contain the notions of interventions, participation and sustainability for all stakeholders and participants (including the farmers, businesses, financial transactions and also the public and private sector investors).

This broader approach to defining a project allows project objectives to include aspects such as increased farm income, employment creation, distributional aspects, including gender and youth, environmental aspects and national income and other economic growth dimensions. A wide range of criteria measuring micro, as well as, macro impacts will therefore be required to determine whether a project investment is justified or not.

These views also provide for an analytical framework for managing and analysing information across the expected life of a project. It allows for comparison of several projects, or alternative designs of the same project. A major limitation/challenge of the project format however is its reliance on quality data estimates or projections of expected benefits and costs.

Classification of Development Projects

In the abovementioned views the main emphasis is on *change*, *participation* and *interventions* as component of development. Many projects aimed at change in agriculture can therefore be seen in relation to development. The following functional classification is useful:

Projects aimed at technological innovation

The objectives of this type of projects relate to the technical transformation of the agricultural sector. The issue here is the enhancement of technical effectiveness while the goal is an increase profit through an increase in physical production per unit, ie. improved productivity.

The key to success of this type of project lies in offsetting of risks and uncertainty by participating farmers. Should there be a small degree of risk acceptance by participants and/or should technological innovation be extremely risky, a technology innovation of project cannot be given a fair chance of success, ie. the *"with new technology"* situation may not be more beneficial as the *"without new technology"* situation.

Expanding the natural resource base

This type of project is aimed at change and development by unlocking natural resources such as water and land for production purposes. These projects are often tackled on a large scale and are often viewed as *"glamour projects"*. This type of project can make a tremendous contribution towards production and agricultural development. In rural development planning, however, it must also be viewed critically, *inter alia* because of the history of limited broad base impact of such projects on the general improvement in rural living standards. The group who benefits from this type of development is often small, while a large number of complementary inputs are required for the project to succeed. A greater impact is often observed where attention is instead given to a number of smaller projects within a well-constructed development program re constructing weirs to sustain small-scale irrigation development and improving market facilities. It seems that this type of agricultural project should thus, only in exceptional cases, be incorporated in a rural strategy. The large-scale project approach is examined in more detail later.

Improvement in the living conditions of previously disadvantaged groups

This type of project aims to improve the general living conditions of specific groups. Here the issue is not to unlock natural resources per se. It can be seen instead as a *"conscious public decision to intervene in the market process and change the ownership structure of the factors of production and to channel the projects' benefits towards designated target groups"*.

Projects in agricultural credit, rural settlement, land reform, food production and integrated rural development focusing on the designated target group(s) are included in this category.

Such projects clearly fall within the field of public sector assistance and participation rather than on the establishment of commercial agricultural production through optimal resource utilisation.

Improved market infrastructure

Improvement in market infrastructure is extremely important in developing agriculture. Harvesting, grading, storage and transportation may lead to a considerable increase in surplus food and fibre. However, such projects are not merely intended to support commercial programmes. Low-input, broad-based focused programs could also be supplemented by projects that stimulate the flow of inputs and proceeds.

Institutional capacity development

Modern agriculture requires a support system consisting of a number of functional components. These components are provided within an institutional framework. Institutional capacity is currently viewed as one of the most limiting factors in the process of agricultural and rural development.

This type of institutionally orientated project aims, in particular, to create a human and organisational infrastructure that strengthens and supports local initiatives so that decision-making, the choice and implementation of programs and projects, resource allocation and monitoring can take place on a more decentralised and informed basis.

Within these types of projects, the focus is on three levels, viz on macro or central level, regional level and on the level of participating groups and individuals.

The main objective is to improve effective participation. From this point of view, production may be constrained in the short term because more attention is given to human capacity development and mobilisation, ie. empowerment. In the long term, however, the development of capacity on each level may, to a large extent, give rise to increased production and productivity.

Multifunctional investment projects

A sixth type of project may be added, viz where more than one of the abovementioned functions is undertaken jointly within one project. With a commercialisation approach it is in any case important that all inputs of the *"package"* are complementary to and reinforcing one another.

The development project format as defined in section 1.1 provide a suitable framework to co-ordinate such functions and manage them available as a *"package"*.

Policy and institutional reforms

Institutional reforms often follow policy reforms. Such initiatives may not require major investment activity *per sé*. However, good projects require good policy frameworks. The investment in policy and institutional reforms are therefore important to optimise the impacts of development project types (1.3.1 – 1.3.7) (see also Chapter 6).

Agricultural Development Projects: The Cutting Edge of Rural Development?

The most difficult single problem confronting society is the implementation of development initiatives. Much of this can be traced to poor project preparation and planning and/or bad project selection and/or poor implementation. Unless projects are carefully prepared and appraised, inefficient or even wasteful expenditure is almost sure to result.

If development is pictured as a progression with many dimensions – spatial, technical, social, cultural, financial, environmental and economic – projects can be seen as an undertaking to enhance development through change. When all dimensions are attended to in a thorough and well considered manner projects become focussed and driven entities to promote development over time.

A project can also be observed with at least a conceptual boundary around, ie. containing the physical structures, financial flows, beneficiaries and participants. An observer can thus clearly say *"this is the project"*. A project furthermore has a start and finish.

Given the usefulness of the project format, the project concept has increasingly been used as an instrument to promote development and change. In this context, a good and well-designed project can indeed be the *"cutting edge"* in a development strategy (Gittinger, 1982). Some of the key issues related to this "cutting edge" ideal are discussed in the following sections.

- **Projects within the framework of development planning:** Agricultural development projects do not function in a vacuum. Projects can be regarded as the final link in the process of development planning and implementation. A **project is seen as a concentrated and clearly defined action within a development programme**. A project therefore originates from a certain strategy within the prevailing of agricultural and rural development policy.

  In views of the aforementioned definitions and description of the potential role of an agricultural development project, the focus of agricultural development projects can be classified as actions aimed largely at optimal effectiveness (allocative and technical). Development *projects* must thus be *judged* primarily on the basis of *effectiveness*; *productivity* and *economic efficiency*. *Equity* considerations, however, must also apply in project evaluation and must receive attention. A high input type of agricultural project (such as irrigation projects) which is not driven by the economic principle of optimisation (marginal benefits = marginal costs), will clearly be in danger of producing unacceptable financial and economic results, especially for participating groups. Should the financial results, for example, be unacceptable (rate of return on capital not high enough, net farming income too low and direct benefits < direct costs) a project can not make a meaningful contribution in broader social terms towards prosperity and equity as such a project would in fact be bankrupt.

  The broad economic and social objectives of an agricultural development project can thus also be seen as the improvement of prosperity within a country or region by giving preference to efficiency driven actions.

  If the achievements of agricultural development projects are examined the results often seem disappointed, even shocking. An analysis of large-scale projects often points to the opposite outcomes of what was intended, planned and expected to happen.

  A popular view therefore concludes that it is virtually impossible to launch a successful large-scale project in less developed African countries. The reason for this is that large-scale intervention has to be planned in the presence of too many unknowns. It can also be concluded that many of these schemes in Africa failed as a result of elementary mistakes that were made and, to a large extent, repeated from project to project.

Hans Ruthenberg (1971) observes that *"some large large-scale farming is useful under almost all conditions but smallholder farming is generally more economic in national terms provided inputs, innovations and markets are supplied"*. The main reason for this is the low opportunity cost of small-scale farming. Opportunity costs or *"without project scenarios"* should therefore be included when evaluating any project.

It seems as if the finding as to whether a project is a success or failure is determined largely by the criteria used to judge a project. In this regard it is interesting that Uma Lele and Robert Chambers, both well known experts on projects and both of whom in principle prefer redistribution of assets in order to involve the masses on a broad basis in development, reach the conclusion that poor countries cannot afford not to utilise special growth possibilities via large-scale project development.

- **Project multiplier and linkage effects:** Project investment seldom only results in direct impacts ie. those which only affect the project beneficiaries. A whole range of effects can be recorded. These would include the direct or primary impacts on project participants (ie. increased agricultural productivity) and a range of indirect or secondary impacts such as the multiplier effect generated by the increased income earned by project participants, wage labourers, professionals working on the projects, etc; employment linkages in up- and down stream activities required to serve the project, and a range of external effects which could include environmental, ecological, institutional and social impacts.

  The true impact of a project should thus be assessed in terms of all these effects in order to determine the real contribution. Studies show that investment in the agricultural sector (especially of a developing country) generates substantial multiplier and linkage effects – generally generate much greater impact than investments in other economic sectors.

- **The choice of capital intensity in project investment:** Within a developing economy, labour is often available in surplus quantities while capital is an extremely scarce resource. During project appraisal this particular situation means that a very low social cost (shadow price) must be placed on the employment of labour. Capital intensive projects should therefore, on social and economic analysis, be more "expensive" than labour intensive projects. Given the fact that capital intensive project should in certain circumstances enjoy priority, the question is still to what degree capital intensive projects must be included in development planning. How intensively must capital be used? In this regard it is worth noting:

  (i) Even if the cost of labour were extremely low, it would be a mistake (also impossible) to replace capital entirely with labour if economic growth is an objective.

  (ii) It might be required to give preference to labour intensive projects especially if a portion of the surpluses generated by the project can be *"collected"* by the state in terms of savings, levies and taxation. However, in less developing economies, where the extended family relationship is often strong, surpluses could *"disappear"* immediately. Large labour complements might also be difficult to manage. However, due to these conditions capital intensive projects may offer a greater possibility of *"taxing production"* and, in the process, mobilising capital for further development.

  (iii) Social pressure for higher wages and other labour demands often makes the more capital-intensive technique preferable, especially if long-term considerations are borne in mind.

- **The equity status of projects:** Project development does not automatically lead to equity problems. If a project can facilitate a Pareto movement (ie. the improvement of one group's living conditions without affecting those of any other group) no objection can be raised from a wealth distribution point of view. However, if certain production factors are scarce, thus reflecting high opportunity costs in respect of alternative uses, the concentration of such production factors within the framework of one project benefiting a particular group, may result in a disproportionate distribution of income. Where establishment of a project benefits the participating group to the detriment of other groups, the appraisal of such project must give due consideration to compensation mechanisms. The total impact of the project, including the compensation effect, must be taken into account before a realistic judgement can be made regarding the contribution of the project and the success/failure thereof in terms of equity considerations.

The view that agricultural development projects are generally *"islands of prosperity amidst an ocean of poverty"* is therefore not necessarily valid. However, the objective should still be to, as far as possible, preventing such *"island"* types of situations from arising. This will largely facilitate the social sustainability of a project.

Why do agricultural projects fail?: History records the dismal failure of the so-called project approach. What are the reasons for this? The concept clearly proves to be sound. It may, however, be that the project design is flawed or that implementation is at fault; it may be a poor inaccurate project analysis; or it may be unforeseen economic, natural or political changes.

A comprehensive list of *"where things went wrong"* will include the following (see Gittinger, 1982; Tisdell, 1985; for more details):

- A lack of local ownership and responsibility, ie. participative planning and development.
- Problems of project design and implementation.
- The use of inappropriate technology, cropping systems and animal husbandry.
- Inadequate or inappropriate infrastructure.
- A weak support system.
- Failure to appreciate the social and political environment.
- Administrative problems.
- Changing economic situations and market conditions.
- Externally driven project initiatives.
- Problems related to poor project analysis.
- Unrealistic expectations.
- Unsupportive policy environment.

The future of the project approach?: Participatory planning and development is one of the fundamental building blocks for sustained growth and change. The participation of the beneficiaries at all stages of the project cycle is critical to ensure success. The project planning format, as discussed in chapter 3, lends itself to accommodate such participation. With the proper attention to detail and with the elimination of the mistakes listed above, projects should be viewed and could indeed be used as the *"cutting edge"* for development in the agricultural and rural environment. This will, however, require a sourced policy and institutional framework.

Analytical Aspects of the Project Approach

In the previous sections a project was viewed as an investment activity in which financial resources are expected to create capital assets that produce benefits over an extended period. A project is, therefore, a clearer, distinct portion of a larger, less precisely defined program. The project format is used to prepare and analyse a variety of agricultural investments and is an analytical tool for analysing information on a consistent basis across the expected life or different phases of an development initiative. The project approach to planning allows for comparison of several projects, or alternative designs of the same project, ie. alternative options, thus making the resource allocation process efficient.

A major limitation of the project approach is its reliance on quality data estimates and projections. The project format is also only a *"partial analysis"*.

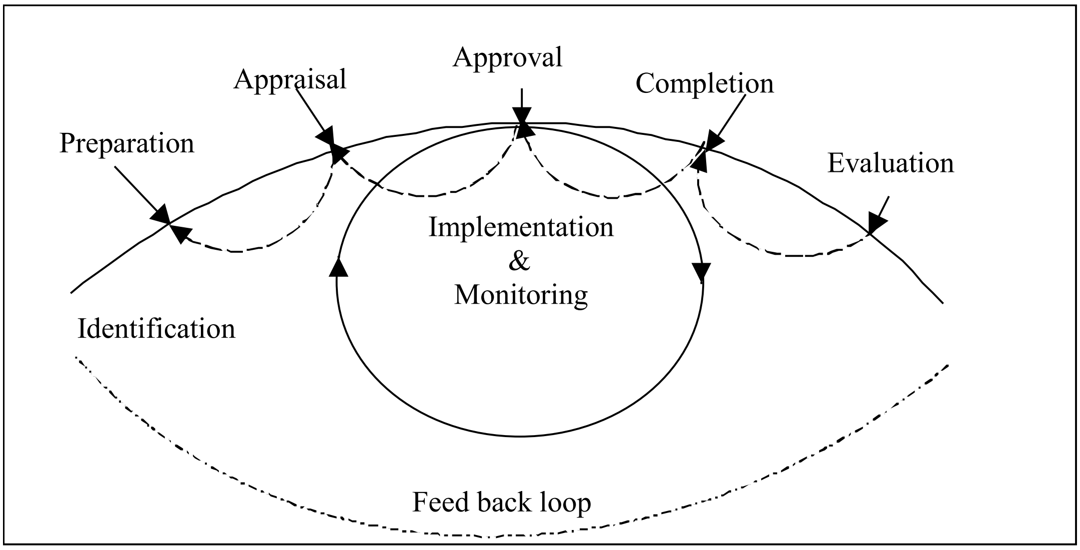
The concept of project cycle and its various components are discussed in this section.

The project cycle

A project moves through stages. An idea germinates; then it passes through various steps which will clarify the concept; objectives and activities required to achieve the objectives; the appraisal of the alternative options and actions; decision making; implementation; monitoring; completion and final evaluation. The entire process from the first idea to the final evaluation is called a **PROJECT CYCLE**, to indicate the phased or cyclical nature of this process.

In operational terms each stage in the project cycle can be understood as leading to a decision point. The decision to be taken at the end of each stage is if the project should continue to the next stage, and when it should continue. The various elements or stages in the project cycle are shown in Figure 1.2 with feedback processes between each stage in the cycle. The project cycle is thus interactive in nature.

Figure 1.2: The Project Cycle



ELEMENTS OF THE PROJECT CYCLE:

- Identification
- Preparation
- Appraisal (*ex-ante* analysis)
  - ∗ approval/rejection
- Implementation
  - ∗ investment period
  - ∗ development period
  - ∗ monitoring
  - ∗ completion
- Evaluation (*ex-post* analysis) including impact assessment

IDENTIFICATION: The identification stage involves finding potentially fundable projects. Sources include technical specialists, local leaders, proposals to extend existing projects, rise in market price for products, projection of future demand, economic development plans with priority areas, separate sector surveys of the current situation in agriculture, and so on. In the case of agricultural and natural resources projects, the diagnostic surveys and constraint analysis may result in the identification of priority problems and research themes, which may lead to project development.

PREPARATION: Preparation can be broken into two parts depending on size and complexity of the project. A *pre-feasibility* study focussing on qualitative and subjective analysis, could provide enough information for deciding to proceed with a more detailed analysis. During the pre-feasibility stage, the major objectives of the project are however clearly defined. The question of whether alternative ways to achieve the same objective may be preferable should explicitly be addressed and poor alternatives excluded. The analytical aspects come into play at this stage, but often relying on existing and secondary sources of data. Once the pre-feasibility study is done, detailed planning and analysis follows. With large projects, the project may be prepared by a special team to include experts from the analytical areas considered crucial. These steps involve lot of brainstorming and subjective judgement. The analysis will include aspects described in the section of project modules (see 2.2). A so-called "screening" exercise during planning ensure that the project identified is technically and economically viable, and compatible with the existing production systems, resource use patterns, as well as the social and cultural beliefs of the target group.

APPRAISAL: After the report on the detailed analysis of all relevant project modules is completed, a critical review and appraisal of all these aspects are conducted by an independent team. This team re-examines every aspect regarding feasibility, soundness and appropriateness. The team may recommend further preparation work if some data are questionable or some of the assumptions are faulty.

Approval of a project triggers the required set of implementation actions.

IMPLEMENTATION: Implementation is a crucial part of the project cycle and, therefore, requires equally rigorous analysis and planning in order to develop a realistic project management plan.

The implementation is usually subdivided into the following stages:

- **Investment period** – in an agricultural project usually 2-5 years from the start of a project during which the major fixed investments are made, ie. dam and canal systems, most staff is engaged, equipment procured, etc. The major benefits are expected to flow after this stage.
- **Development period follows investment.**
- **Monitoring of project activities as per the approved project and adjustments as required to keep the project on tract.**
- **Completion or maturity of a project can be as long as 25 – 30 years from the start** during which periodic benefits and costs continue to accrue, and impacts are more apparent and measurable.

EVALUATION (AND IMPACT ASSESSMENT): Evaluation involves measuring elements of success and failure of the project. Evaluation can start from on-going monitoring, to after completion of the project. Evaluation is usually done by an independent evaluation team. Evaluation (*or ex-post analysis*) looks at the extent to which original objectives and specifications are met, in other words:

- Technical appropriateness.
- Organisation/institution/management.
- Commercial undertaking.
- Financial aspects.
- Soundness of assumptions.
- Economic implications.
- Social and distributional issues.

Impact assessment goes beyond direct evaluation to look at the results of projects, both intended and unintended, and the differences, positive and negative, on the position of society that has been affected.

The evaluation stage is usually used as "lessons-from-experience" for future project planning and analysis.

Project modules – a framework of analysis

Project analysis can be divided into seven major modules or elements:

- Technical
- Institutional
- Organisational
- Social
- Commercial
- Financial
- Economic
- Environmental aspects

These are all inter-related, and the importance of each varies from project to project, or design to design. This list, however, is a comprehensive attempt to identify relevant processes, data and information that determine benefits and costs. This list, therefore, is used to identify analytical elements for each stage in the project cycle, ie. during preparation, analysis, and subsequent evaluation, and impact assessment. Each aspect is discussed in detail in the following sections.

TECHNICAL ASPECTS: Technical aspects concern the physical inputs and outputs of real goods and services, and examine the technical relations in the project. These will vary from project to project. Experts need to provide information on all major elements that lead to the identification of supplies, production, productivity, and technical input/output coefficients. Project analysts have to make sure that technical estimates and projections relate to realistic conditions.

INSTITUTIONAL – ORGANISATIONAL – MANAGERIAL ASPECTS: Appropriateness of the institutional setting (ie. rules of conduct) is important for the success of the project. Customs and culture of participants have to be understood and accounted for to avoid disruptions in the way in which farmers are accustomed, and hence, increase the possibility of adoption and success. Some important aspects include land tenure, indigenous farmer organisations, authority, and responsibility. The organisational structure, inter-organisational linkages and efficient management of the organisations are crucial for success.

SOCIAL ASPECTS: Broader social implications, particularly resource and income distribution impacts or potential impacts are important. Responsiveness to national objectives may be a consideration. Other aspects include employment opportunities, regional dimensions, losers and gainers in terms of social groups, gender issues, impact on social organisations, change in tenurial division of labour, quality of life improvement, ie. water, health, education, etc.

COMMERCIAL AND BUSINESS ASPECTS: Commercial aspects include market demand for the product, effects on prices, processing and value added effects, and effects on the domestic and/or export market, and quality of the product. Input supply and demand issues include: securing supplies (fertiliser, pesticides, seed) and financing etc.

FINANCIAL ASPECTS: The financial aspects are one of the most important areas in project analysis, and most data have to be translated into financial forms for comparability. Financial aspects include the financial effect of the project on participants, farmers' firms, public corporations, project agencies, and the national treasury. Financial aspects are dealt with at various levels, ie. firm farm, organisation, or corporate. At the farm level, financial data is often handled in farm budgets. Organisations usually have formalised systems of financial accounting and reporting which may have to be further manipulated to fit into the project format. In financial analysis mostly market prices are used and profits are important.

ECONOMIC ASPECTS: The economic aspects are the most important in ultimately determining impact of any public sector investment in agriculture. Economic aspects lead to impact and economic efficiency of the project on development of the total economy, vis-à-vis the allocation of scarce resources, ie. economic efficiency. Economic aspects determine the value of the project from the viewpoint of society at large and also to determine the economic efficiency with which scarce resources are allocated. In economic analysis the concept of opportunity costs are used. Financial and economic aspects are complementary but different, especially when markets are distorted.

ENVIRONMENTAL ASPECTS: Environmental aspects deal primarily with adverse biological and physical environmental impacts, ie. irrigation, bilharzia, notable scenic beauty, preserving unique plants and animals, etc. See the chapter on environmental impact assessment for further detail.

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PROJECT PLANNING METHODOLOGY

Introduction

Project planning represents processes during the identification and preparation stages of the project cycle whereby the broad context in which a project will operate is clarified; where particular problem areas are identified and clear objectives are set to achieve the required changes; where alternatives are developed and choices are made; and where appropriate actions are prepared for implementation. Project planning also provides the framework for project management, implementation, monitoring and evaluation. To participate in and manage the planning process it is important to learn to work with uncertainty, subjective perceptions and values, and flexibility, openness and communication. Participation is a key to successful project planning. The Logical Framework Approach is very useful in effective participative project planning. The concept and procedure of Logical Framework Analysis is discussed in this chapter.

Logical Framework Analysis (LFA)

The LFA approach is a tool for planning, monitoring and evaluating projects. This is also a useful approach to link projects (at the micro level) to the broader context of regional development programs and national goals (ie. the macro level).

LFA is essentially used as a tool to clarify cause-effect relationships and to clarify the logical link between project inputs and objectives; project activities and outputs; broader purposes; and the ultimate goals a project could serve. LFA is therefore a systematic planning process based on logical deductions. Experience and knowledge is important to apply LFA.

The origins of LFA

LFA as a planning technique was developed over the past three decades. Several organisations were involved in developing a scientific, standardised planning methodology. A logical framework was set up by USAID to form a matrix within which information is scientifically related to cause and effects. GTZ has worked out a planning method which combines this logical matrix with more systematic study of available data. METAPLAN has developed communication techniques and a participative planning formula which permits to involve representatives of the groups concerned in logical framework matrix development.

Put together, all these efforts have given rise to a system known as "Ziel Orientierte Projekt Planung (ZOPP), translated as "Objective-Oriented Intervention Planning" (OOIP) or today also referred Logframe Analysis or LFA.

LFA is increasingly popular with a range of international agencies such as the EU, the World Bank, ADB, SADC and many donor governments. This may produce a "knock-on" effect as the same methodology is more widely adopted everywhere. This may help to alleviate some of the problems caused by the concurrent use of many different procedures by sponsors.

LFA - A participative tool

LFA aims at analysing, planning, implementing and evaluating a development intervention with a view to improving quality, adopting a more systematic or logical approach and aiming at better communication and the capturing of knowledge and experience of the groups concerned during the planning phases.

The need for such a participative approach is borne out by the knowledge that in project planning:

- the experience, know-how and skills of the groups in question must be put to optimum use;
- consensus is vital since it is no use forcing people "for their own good" into a project; and that
- Mahatma Ghandi's motto: "something done for me but without me is something done against me" still holds true, particularly in development planning.

Development planners have found that interventions carried out without the participation of those directly concerned are regarded as the sponsor's milk-cows, made for milking, not as tools with which the people concerned can take their own development in hand.

LFA - Its potential and its limitations

"It would be unfair to criticise a car because it does not fly". The same applies to LFA which after all is a tool or method, but no more; yet without method, science would not exist and humankind would be out in the cold.

LFA helps those responsible for investigating interventions in a logical manner to improve the way in which they structure and formulate their thinking and to express their thoughts adequately, clearly and in a standardised way, i.e. a tool for improved planning. LFA has no ambitions beyond that.

Applied within bad policy or when using the wrong criteria, LFA *will highlight incoherence and shortcomings* but it *will not come up with a better policy or produce different criteria*.

LFA is a tool for users. Still, both its quality and its results depend on the quality of the users, on that of the preparatory surveys, on the accuracy of available data and on the commitment of those representing the groups concerned.

LFA - Its scope

The logic of the method is not, in principle, confined to a particular type of problem. In practice, however, the method is particularly appropriate to interventions such as technical and investment projects serving economic development and/or social ends.

For smaller interventions, the method may be applied on a reduced scale, ie. amongst officials only. Large scale interventions (ie. costly and/or complex interventions) on the other hand would benefit if the method were applied wholesale: for example a seminar would round off the preparatory work to compare the expert's findings and adjust them to take on board the opinions expressed by the representatives of the groups concerned.

LFA: A tool for the planning of change

LFA is a tool for managing development processes. LFA can be used simply to structure and create an overview of the plan of a project on a single sheet of paper. LFA can also be used to foster commitment to transparent, structured, participatory and flexible development processes.

LFA is not sufficient to achieve this alone. But it can function as a "master tool" for analysis of and dialogue about development issues.

The LFA Process

LFA is simply a planning tool that provides a structure for specifying the components of an activity or activities, and the logical linkages between a set of means and a set of ends. It places a project in its larger framework of objectives. It serves as a useful tool for defining inputs, time tables, assumptions for success, outputs and measurable indicators or "milestones" for monitoring and evaluating performance. It is a highly effective planning tool.

In the following sections the LFA process will be described. The application of the LFA approach to project planning is described in more detail in the Annexure to this chapter.

The project context

Before beginning work on problem or opportunity identification, it must be clarified why we – individually or as a group – are going into the planning process, and what the task is. It is therefore important to clarify the context of the project by answering the following type of questions:

- How can agricultural production be improved?
- How can farm incomes be stabilised?
- How can added value be generated?
- Who are the major stakeholders and beneficiaries?
- Who will benefit from the project and who will loose out?

The analytical phase

Analysis enables us to collect and profile the data needed to plan the intervention.

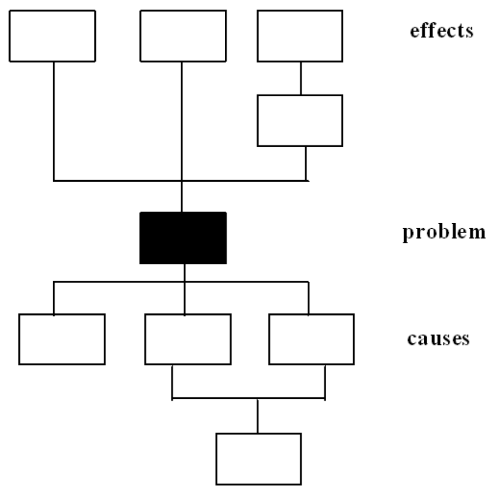
A range of different groups (we) are involved in development issues, such as: the target group or groups, the national government, the regional authorities, the sponsor, the experts carrying out the surveys, the institution responsible for implementing the intervention, and so on.

Each of these parties has its own angle on the situation or has some special contribution to make and they will all seek to put their point of view.

The problems are written out on charts, which are then displayed. A check is made to see that all have understood them; if not, they are re-formulated.

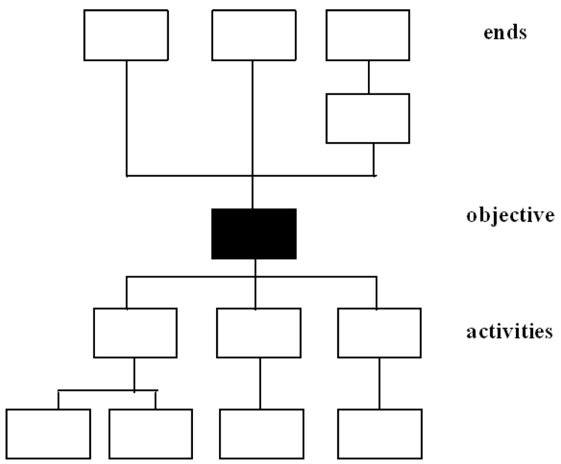
The charts (which include negative states perceived as problems) are displayed in such a way as to highlight the cause-and-effect linkages between the different problems; this exercise will result in a "problem tree" (see Figure 2.1).

Figure 2.1: Developing the Problem Tree



By changing the negative states into positive states and by arranging these in groups reflecting the activities-ends linkages, the problem tree turns into an "objective tree" (see Figure 2.2).

Figure 2.2: Developing the Objective Tree



If the participants accept that the activities-ends linkages are correct and complete, they will then, using the criteria at hand, carry out a "strategy analysis" and select the objectives which will constitute the bounds of the planned intervention.

This, the analytical phase breaks down into three stages:

PROBLEM ANALYSIS →	OBJECTIVES ANALYSIS →	STRATEGY ANALYSIS →
Defining the entity		

Selecting the groups concerned	Converting the negative states into achieved positive states: the objectives	
Establishing a cause-and-effect linkage between problems	Establishing resources-ends linkages between objectives	
Constructing the problem tree	Constructing the objective tree	Pinpointing groups of objectives to establish a coherent strategy
		Comparing these groups using specific selection criteria. Choosing a group of objectives and one purpose.

We now turn to a detailed description of the three sequential stages of the analytical phase.

(i) Problem analysis (Developing a problem tree):

This is a methodological step which enables us to analyse an existing problem situation to identify the problems and put them into order and to highlight the cause-and-effect relationships in a diagram (problem tree).

Description of important elements:

What is problem analysis?	It is establishing cause-and-effect linkages between the negative states of an existing situation.
What is an entity?	An entity is the whole group which determines the bounds of analysis: an economic reality, a geographical region, a social group etc.
How can we determine an entity?	In most cases, the entity is marked out by the government or by groups of a developing country.
How important is problem analysis?	Problem analysis seeks to identify real, important and priority bottlenecks for the groups concerned. Problem analysis is vital to the quality of planning since it maps out a course for the future intervention. A mistake at this stage will affect the entire planning process as well as the way in which the intervention is carried out.
Who takes part in the analysis?	The groups affected by the problems in question and their representatives are identified during the investigation (when TOR is fixed and data compiled and correlated). They will participate in the analysis. (Continued on next page)
What does the problem analysis look like?	It looks like a tree. The trunk is the core problem. The branches and twigs are the effects and the roots are the causes of the situation which is perceived as a negative state.
What is the purpose of problem analysis?	It aims to shed light on the problems posed by an entity and on the way in which these relate to each other.
Which problems are selected?	The actual negative situations recorded by the experts and the groups affected. Priority problems of the target group. The problems must actually exist; future problems or negative solutions (ie. a lack of chemical fertilisers) will not do.
What do we do with the problems thus identified?	All problems mentioned are clearly formulated and checked against the views and problems of the other groups involved. We then try to find a single, clear way of formulating the problems mentioned which satisfies all the groups concerned. If this proves impossible, the different ways of formulating the problem (with contrasting views) are included in the analysis as they are. Based on the problems sub-groups can be formulated.

Steps for the problem analysis:

1. Clarify the entity outlined.
2. Clarify the groups concerned by the entity (or sub-groups as the case may be).

3. Formulate the problems perceived by the groups concerned.

Lack of pesticides	Crop destroyed by vermin
Wrong !!	**Correct !!**
(too unfocussed)	(focussed)

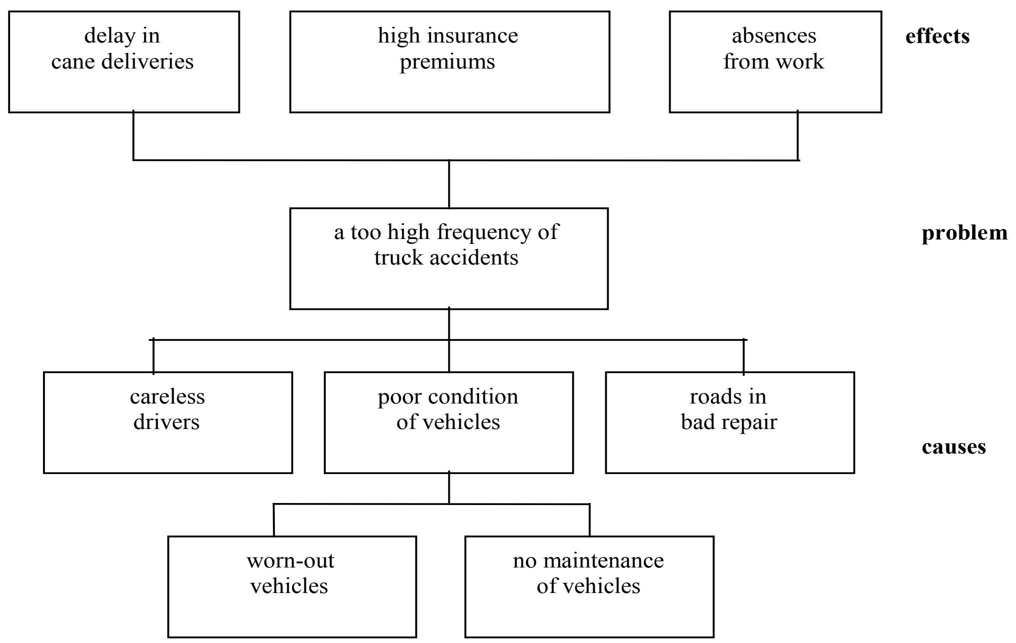
4. Eliminate duplication charts.
5. Check whether all charts are perfectly clear and reformulate them if not.
6. Select a starting problem (a problem with causes and effects).
7. Establish a diagram showing the cause-and-effect linkages between all the charts (the problem tree).

Notes:

- The problems identified must be real/existing problems or constraints, not imaginary or hypothetical problems.
- The importance of a problem does not depend on its position in the hierarchy on the problem tree.
- A problem is not the "absence of a solution" but "a negative state of affairs".

An example of a problem tree is given in Figure 2.3. In this case problems are experienced with the transportation of produce (sugar) from a production site to the processing site (mill).

Figure 2.3: Example of a Problem Tree (Step 7)



The problem to be solved is "a too high frequency of truck accidents".

(ii) Objectives analysis: The objective tree

This is a methodological step which enables us to describe the future situation which will be achieved when the problems are solved; to identify the objectives and pinpoint their position in the hierarchy; to show the activity-ends linkages in a diagram (the objectives tree - Figure 2.4).

Description of important elements:

What do we mean by objectives analysis?	Establishing resources-end linkages between positive states achieved in a targeted future situation.
What does an objectives analysis look like?	It looks like a tree. The trunk is the core objective. The branches and twigs are "ends" and the roots are "resources".
Why do we make an objectives tree?	In order to obtain a clear overall picture of a targeted positive situation in the future.
Does the objectives tree show all possible solutions to given problems?	No. The objectives tree arises directly from the conversion of negative states into positive states, ie. objectives. Hence the tree may not necessarily show all possible solutions to the problems in hand.
How do we change a problem into an objective?	The negative state is converted into an improved (positive) state which is achieved (projected into the future).
Can all problems be changed into objectives?	In principle, all problems can be changed into objectives. However, unrealistic objectives (ie. enough rain) or ethically unacceptable objectives (ie. all inhabitants to become Moslems) are not included in the objectives tree. In this case, the problem is reformulated and the objective will be correspondingly different. (Continued on next page)
What happens to "controversial" objectives?	"Controversial" objectives sometimes result from lack of understanding or poor formulation of the problems. In this case, the problem must be formulated more carefully so as to enable us to formulate an objective we can agree on. If the objective remains controversial, we drop it for the time being until we can bring fresh ideas to the subject. If the controversy continues and consensus proves impossible, the views of the different groups concerned must be shown together. A decision will be made as work progresses. Sometimes a controversial objective is shown in the objectives tree. It will probably become an assumption.

Steps for the objectives analysis:

1. Formulate all the negative states in the problem tree to show them as positive states achieved in the future.
2. Check that the conversion of problems into objectives is realistic and acceptable from an ethical standpoint.
3. Check that the "cause-and-effect" linkages have effectively turned into "activity-ends" relationships and that the diagram is both complete and valid. If not, adjust the logic.
4. If necessary:
   - Change some of the formulations (to weed out nonsense or ethically debatable statements).
   - Eliminate objectives which are undesirable or unnecessary.

Note:

The objectives must be expressed as a "state":

production increase	production increased
Wrong !!	**Correct !!**

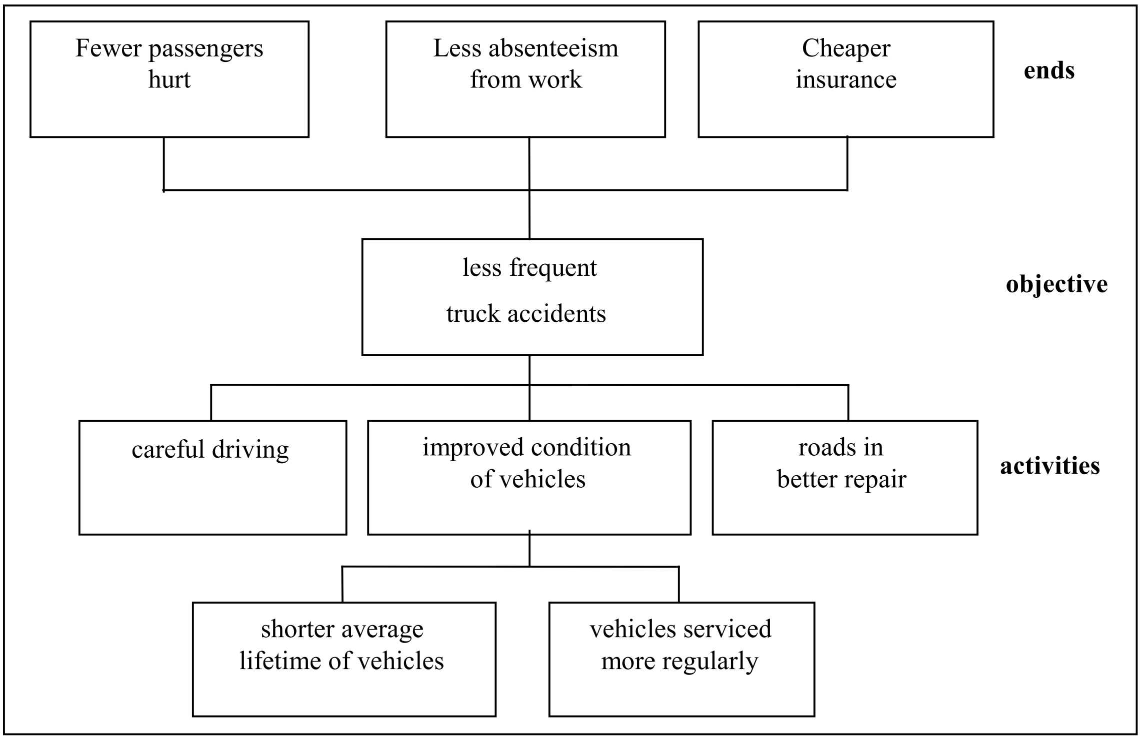
Not all "cause-and effect" linkages can automatically be changed into a "activity-ends" relationship.

For example:

soil exhaustion	soil fertility restored
excessive demographic growth	demographic growth checked

Example of an objectives tree (from the previous problem tree)

Figure 2.4: Example of an objectives tree



Strategy analysis

This is a stage which enables us to identify the different strategies possible to achieve the objectives and to select the strategy to be adopted by the intervention (or project) we are planning.

Description of important elements:

What is strategy analysis?	It means pooling interlinked objectives to form an ensemble of objectives.
Why do we need strategy analysis?	Choices must be made since budget, time and other resources are not unlimited. That is why groups of objectives must be clearly specified and compared so that we may make a choice which will produce or achieve the purposes of the future intervention. We refer to a group of interlinked objectives as the "intervention strategy".
Is the choice of strategy a definitive one?	No. The chosen strategy is a first choice which may be adjusted, as the intervention becomes more operationalised.
What criteria do we use to make a choice?	The selection criteria differ from case to case: • Decision makers and development authorities applies general criteria as well as political and technical criteria; • Donor institutions/a country should develop its own development policy and criteria for projects and programmes; • the target group has its own criteria; etc.
What happens to the objectives we reject?	If the groups concerned feel the rejected objectiveness is nevertheless important, they should be realised as part of another (or several other) parallel intervention(s).

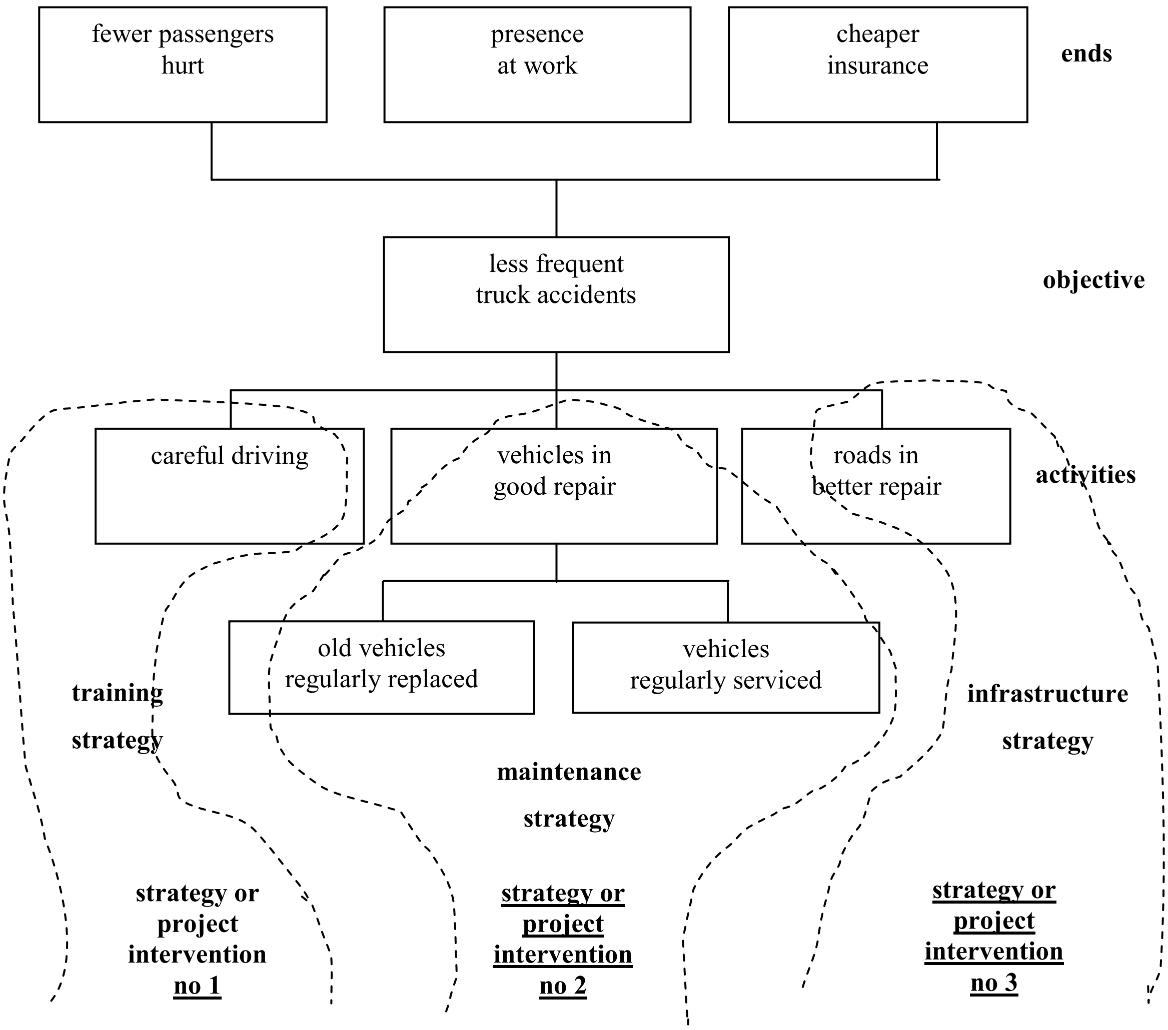
Steps for strategy analysis:

1. Choose the goal, ie. the objective to which several interventions will contribute.
2. Specify the activity-ends chains (intervention strategies) which will contribute to achieving the goal.
3. Determine the most favourable and feasible chains, using, for example, the following criteria:
   - the availability of resources,

- the relevance of the purpose to the goal,- its importance to the target group and the interest shown by the latter,
- the chances of success,- the link with development policy,
- the induced (ie. unplanned) negative and positive effects,
- the time frame available,
- the degree of urgency,
- (if necessary) the historical background of the intervention,
- the ability of the local institutions which will be responsible for the intervention, etc.

4. Choose an activity-ends chain which will become the strategy of the future intervention, ie. the major focus of the planned project.

Figure 2.5: Example of a "strategy analysis":



The planning phase: Completing the logframe matrix

Describing the matrix

When we have analysed the situation, our next step is to plan the intervention. The planning phase aims at setting up a logical framework (logframe), in the form of a summary matrix showing four vertical columns and four horizontal ones:

LOGFRAME

	Columns			
Intervention Logic		**Objectively verifiable indicators**	**Sources of verification**	**Assumptions**
Goal				
Purpose				
Intermediate Results (outputs)				
Activities & inputs		**Resources**	**Cost**	

Column one shows the (project) **INTERVENTION LOGIC (IL)** which follows from the objectives tree. It is a narrative summarising:

The goal: The future state at a high level, to which several interventions will contribute.

The purpose (or objective): The future state targeted by the project intervention itself.

The intermediate results (or outputs): The future intermediate states or outputs to be brought about by the intervention and which together aim at achieving the purpose. The (project) intervention leader is responsible for achieving intermediate results.

The activities: The work which must be carried out as part of the intervention in order to achieve the intermediate result. The intervention leader is responsible for carrying out and managing these activities.

Column two shows the **OBJECTIVELY VERIFIABLE INDICATORS (OVI)**. These describe the goal, the purpose and the intermediate results in operational terms, ie. in terms of quality, quantity, place and time. An indicator describe "milestones" of progress and enables detailed follow-up and monitoring.

This column shows the **RESOURCES** needed to carry out the planned activities.

Column three shows the **SOURCES OF VERIFICATION**. These indicate where and in what form information may be obtained in order to verify progress towards achieving the goal, the purpose and the intermediate results.

This column also includes the **COST** of the resources needed to carry out the activities.

Column four shows **ASSUMPTIONS**: External factors over which the intervention has no direct control but which are nevertheless important with a view of achieving the intermediate results, the purpose and the goal. The intervention leader is not responsible for these assumptions but must bear them in mind, monitor them closely, take them into account and if possible, exert some influence over them.

The logframe matrix summarises the intervention in one (full) page as follows:

WHAT IS THE GOAL of the (project) intervention being carried out?

WHAT IS THE PURPOSE of the (project) intervention?

HOW does the intervention contribute to this objective (intermediate results)?

WHAT WILL the intervention **DO** (activities)?

WHICH crucially important external factors will determine the success, or failure, of the intervention (assumptions)?

WHERE can we find the data needed to administer, monitor and evaluate the intervention (sources of verification)?

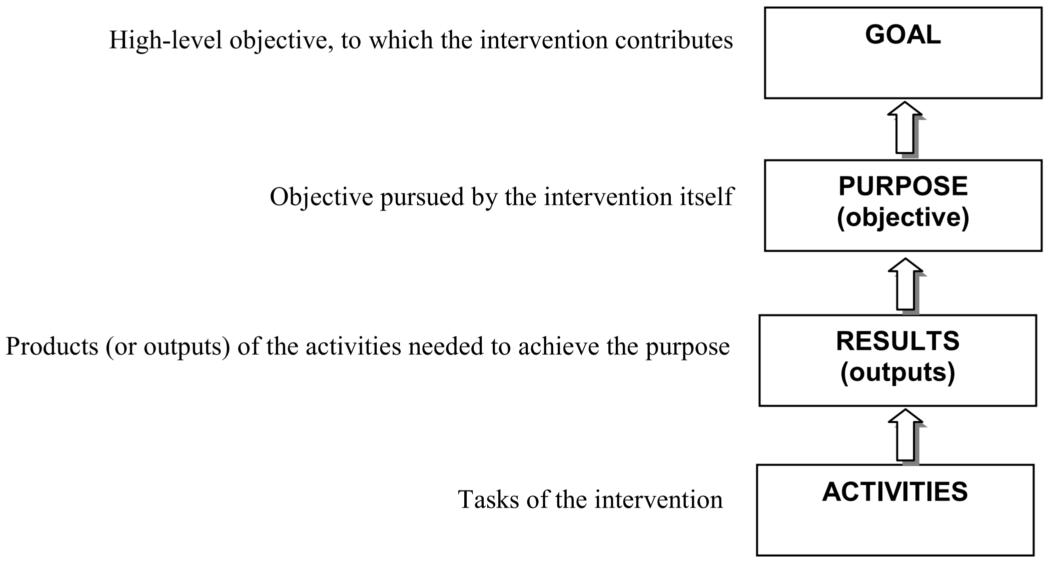
WHAT resources – and their cost – are involved in the intervention?

Description of the intervention logic

The intervention logic comprises all stages contained within the (project) intervention, which need to be completed in order to achieve the goal:

- intermediate results are achieved through the activities,
- the purpose is realised through the intermediate results,
- the goal is reached via the purpose.

The following sequence is adhered to:



Description of important elements:

Which data are included in the intervention logic?	The intervention logic comprises: The overall goal of the intervention. The immediate purpose of the intervention. The way in which the intervention will contribute to the latter (intermediate results). What the intervention will do (activities).
How important is the goal?	The goal is a focal reference, which enables us to determine the content of the interventions which will contribute to it.
How important is the purpose?	The purpose is a focal reference (or development objective) which enables us to administer the intervention and to gauge its chances of success or failure.
Why is there only one purpose?	There is only one purpose for each intervention in order: to prevent the intervention from becoming too sophisticated for proper management; to avoid a clash between purposes (this is one reason why the “integrated interventions” of the 1970s failed). It is better to have two (parallel and inter-related) separate interventions than a single intervention featuring two different purposes.
From what/where do we deduce the results?	The results (or outputs) are deduced from the objectives tree or else follow from specific technical surveys.
How do we determine the activities?	The activities are deduced from the objectives tree; follow from specific technical surveys carried out by members of the investigation mission; and are provided by the relevant groups after consultation.
Why must we plan the activities?	The activities must be sufficiently well-prepared for us to be reasonably confident about: drawing up a rough working schedule and calculating the likely duration of the intervention; deducing the human and material requirements; calculating the budget.

What is the procedure for determining the intervention logic:

To identify the goal:

1. Study the objectives tree and select “the objective” situated at the head of a group of chains. This “objective” is now the goal. It is formulated as a positive state to be achieved; hence we should employ a past participle.

To identify the purpose:

2. Study the objectives tree and select “the objective” situated at the head of the chain. This “objective” has now become the purpose. It is formulated as a positive state to be achieved; we should therefore employ a past participle.

To identify the results:

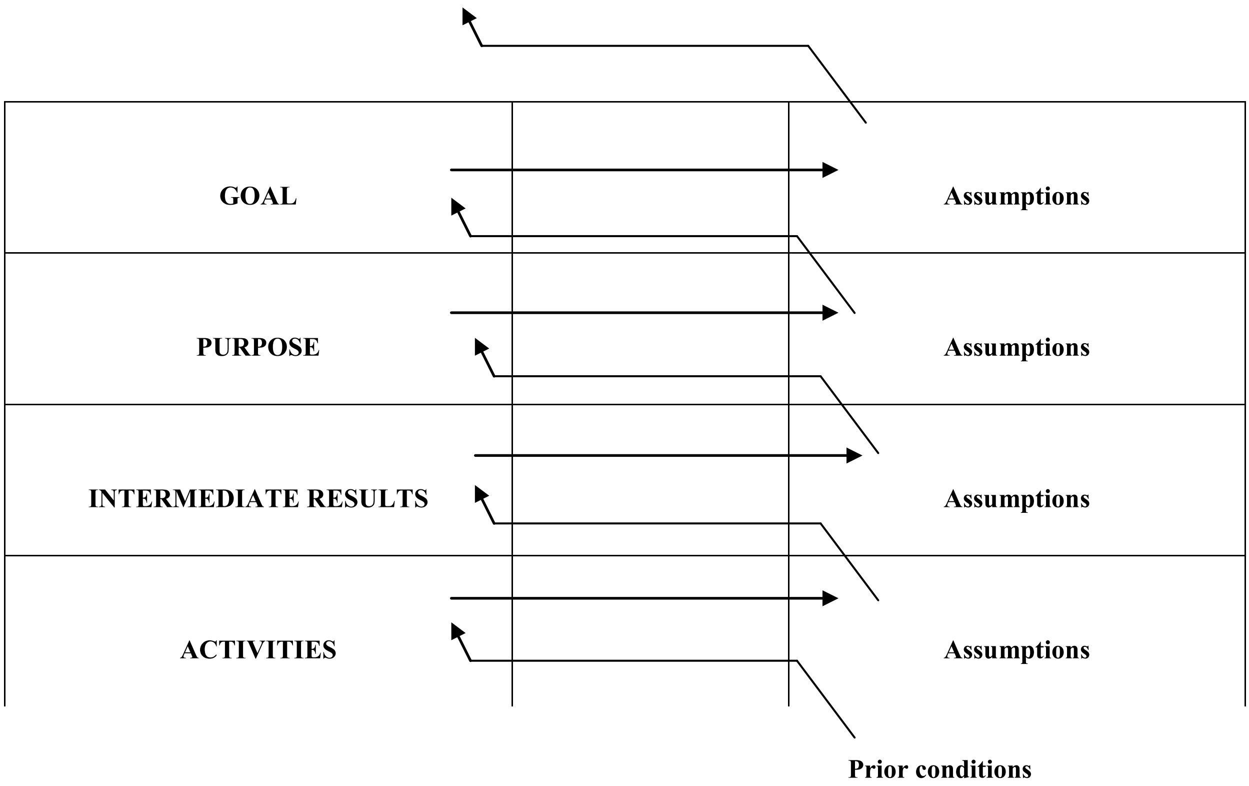
3. Study the objectives tree and select those “objectives” which, reasoning along ”resources-ends” lines, will become intermediate results. These are formulated as positive states to be achieved; we should therefore use past participles.
4. If necessary, you should now add other intermediate results to achieve the purpose. These may have been identified by the groups concerned or supplied by technical staff.

To identify the activities:

5. Study the objectives tree and select the “objectives” which, according to the “resources-ends” logic, will produce intermediate results. These “objectives” are now activities. They are formulated as steps to be taken; hence we should use verbs.
6. If necessary, you should now add other activities to achieve the intermediate results. These extra activities may have been identified by the groups concerned or suggested by technical staff.
7. Number the activities and the intermediate results to create a logical sequence.

   Assumptions: Assumptions are factors not falling within the scope of the intervention which are not or barely affected by the intervention yet are important to bring it to a successful conclusion.

Viability of impact of the intervention



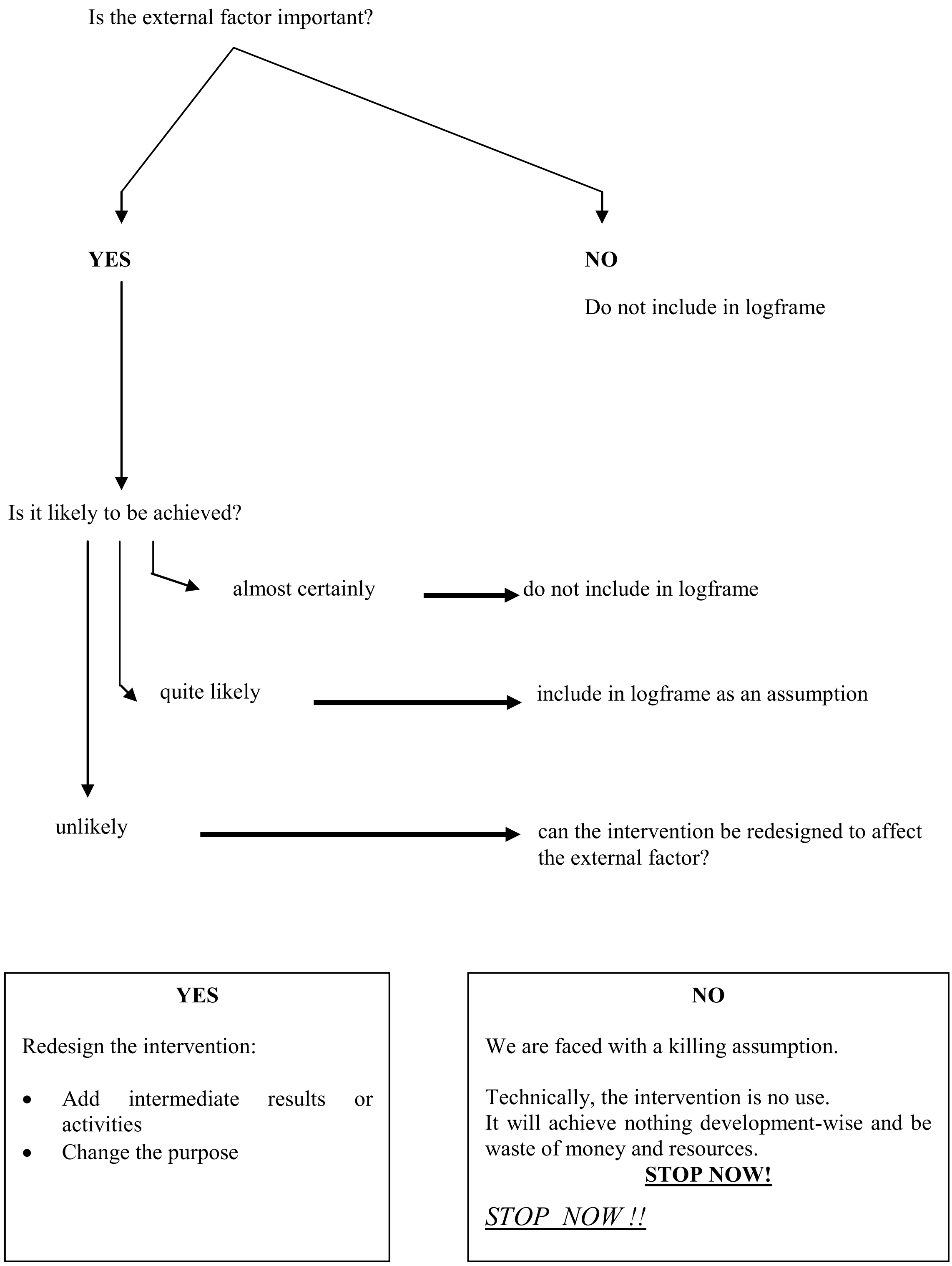
Description of important elements:

Why do we introduce "assumptions"?	The intervention logic never quite tallies with reality. Factors not falling within the scope of the intervention exist and exert considerable influence. Just because they are "outside" does not mean we can ignore them. So it is important to identify them and take them into account.
How important are assumptions?	Most interventions fail does so because of external factors relevant to the intervention. That is why it is important to investigate not only the intervention itself but also to understand the overall setting. If the external factors are negative, it may be preferable to drop the intervention altogether or at any rate redesign it.
Where do we find these external factors?	Some external factors are included as "objectives" in the objectives tree. Others are identified by experts or the groups concerned.
When do external factors become assumptions?	In the course of the investigation, you should judge how important or even vital these external factors would be to the success of the intervention. If an external factor is important but does not fit into the intervention logic, it becomes an assumption and is integrated into the corresponding column in the logframe.
How do we formulate assumptions?	Assumptions are formulated as achieved positive states. This means they can be verified and appraised.
At which level do we situate assumptions?	Assumptions link the different levels featured in the intervention logic. An assumption will therefore be situated at the appropriate level of the intervention logic. Choose the right level depend on the logic linking the intermediate results, the purpose and the goal.
What use is an assumption at the upper level?	It indicates the factors outside the intervention which are needed to assure the planned impact of the intervention.
What is a "prior condition"?	A prior condition is a factor outside the scope of the intervention which must be achieved before the intervention's activities can get underway.

Steps for determining assumptions:

1. Identify the "objectives" on the objectives tree not included within the intervention logic yet important to its completion.
2. Situate these "objectives" at the appropriate level.
3. Identify the other external factors not featured on the objectives tree yet necessary to the success of the intervention.
4. Carry out a check in three stages (at the three levels), starting with the activities of the intervention, to see whether the intervention logic is actually logical and comprehensive. At each level, you should bear in mind the external factors needed to reach the next level. If necessary, add more external factors to column four. Use the diagram overleaf to analyse/appraise conditions.
5. Analyse the external factors identified in order to importance, according to whether they can be integrated with the intervention logic and depending on their chances of success or failure.
6. Depending on the outcome of your analysis:
7. Delete the external factor from column four.
8. Insert the external factor as an assumption and formulate it as a positive state to be achieved.
9. Redesign the intervention.

Appraising external factors: The following sketch is useful in appraising the external factor.



Putting the intervention logic into operational terms:

Objectively Verifiable Indicators (OVI): OVI are measures designed to objectivate (admitting of objective study) the goal, the purpose and the intermediate results.

Description of important elements:

Why do we define OVI?	In order to: • Clarify the salient features of the goal, the purpose and the intermediate results. • Enable objective management of the intervention in order to achieve the intermediate results, the purpose and the goal. • Enable objective monitoring and a reasoned evaluation.
What criteria should OVI meet?	OVI should: • Be specific as to quantity and quality. • Be substantive (cover the main points). • Be independent and different one from the other; each OVI should relate to a single objective or result. • Be reliable, since their evaluation should provide a dependable pointer to the successful outcome of the intervention. • Be verifiable, ie. based on accessible (where and when?) data or on information to be collected by the intervention itself.
Is there only one OVI for each result or objective?	It is often necessary to define several indicators which between them will produce only one reliable piece of information on how to achieve the goal, the purpose and the intermediate results.
Can we always find OVI?	A good OVI enables direct measurement. For example a "production increase" is calculated by adding up crop results. When there is no direct OVI, we must look for "approaching" OVI. For example to gauge the rise in the number of visitors coming to see a certain picture in a museum, measure the amount of wear and tear of the carpet in front of the picture. However, the OVI must give a reliable indication, since the picture may have been hung in a very busy spot, ie. on the way to the restaurant.
Can all objectives be quantified?	It is not always easy to compute goals objectively, but you should try at all times to come up with quantifiable, specifiable and verifiable OVI. Any improvement in this respect is an important step towards easier and more objective management, inspection and evaluation. Quantification continues in the course of the intervention.

Steps for establishing OVI:

Indicators

The key to the log frame in terms of effectiveness is the clear identification of indicators. Here an attempt is made to translate the general objectives to specific objectives, and attach one or more indicators. Here an attempt is made to translate the general objectives, and attach one or more indicators to each specific objective, thus, transforming the general objectives of the project into measurable performance targets. This should not be viewed as a one-shot activity. Indicators may change over time so that log frames may need to be refined in order to better reflect the changing environment of the network/research activity.

In the context of a development project, indicators are used for two main purposes:

- In order to classify or rank societies and social groups based on indicators (macro-level) – quality of life, livelihood and poverty and
- To measure progress relating to interventions for social and economic change at the project and program (micro-level).

Indicators are formulated to measure the achievements of the objectives for each output. Indicators are performance standards, and set the targets for a project. The indicators describe each objective precisely in terms of :

- The quality to be reached;
- The quantity which is set as target;
- The target group which is affected by an objective or that benefits from these objectives;
- The time at which the objective is supposed to be achieved; and
- The location or region where the objective is supposed to be realised.

Therefore, the identified indicators should:

- Be realistic;
- Kept to a minimum;
- Clearly indicate the criteria for attaining objectives;
- Specify the nature, quantity, quality and time required for the objectives to be achieved;
- Be sufficient in number and detail to adequately measure achievement and objectives;
- Be independent of the evaluators; biases i.e. be objective
- Be objectively verifiable and unambiguous;
- Both qualitative and quantitative; and
- For medium to long-term projects, it may be desirable to identify time dependent indicators.

Indicators for the inputs to a program are easier to determine. These can be expressed in terms of resources, activities, personnel time, supplies used, courses attended, funds utilised, etc. Most input can be easily measured or assessed.

However, problems always emerge when identifying and measuring the output indicators. While selecting indicators for output levels, one should:

- Think in terms of expected output;
- Consider the purpose of the activity in terms of targets;
- Answer the questions of what, how many, with which characteristics and when; and
- Consider using proxy measures where appropriate.

Note: Indicators are not always quantifiable but they should be very explicit, as precise as possible, and objectively measurable.

- Indicators provide a basis for monitoring performance and for evaluation
- In the early planning stage, indicators are just guiding values which must be reassessed when the project becomes operational.
- More comprehensive impact studies may reveal unforeseen aspects of an intervention which should be turned into indicators for further monitoring.
- Without having clear and measurable objective it is hard to have clear indicators.

From the above discussion it follows that there are many kinds of indicators:

- Indicators of availability
- Indicators of relevance
- Indicators of accessibility
- Indicators of utilisation
- Indicators of coverage
- Indicators of quality
- Indicators of efforts
- Indicators of efficiency
- Indicators of impact

Indicators are objective and specific measurements of the results of the project. Indicators of output are usually simple (e.g. number of units produced, person trained or verification done). However, measuring the developmental effect of project activities, the impact maybe highly **complicated?** and costly. In such cases qualitative and less objective assessments must be relied on – combination of objective indicators and subjective perceptions oriented indicators as emphasised in Participatory Impact Monitoring.

A good indicator is said to be:

- Substantial in relation to an objective
- Independent at the different levels of objectives
- Factual rather than a subjective impression
- Plausible i.e. the changes recorded can be directly attributed to the indicator
- Based on obtainable data, preferably existing data

These criteria are difficult to fulfil simultaneously in all cases. Thus development impact is difficult to trace back to one particular indicator or even to one particular project. The following steps can be considered:

1. Look for an appropriate indicator for each intermediate result, for the purpose and the goal. The indicator should meet the criteria listed on the preceding page.
2. Specify, for each intermediate result, for the purpose and for the goal:
    - The object or the target group : What, who, how many, what kind …?
    - The quantity : How many?
    - The quality : How?
    - The time : When?
    - The place : Where?
3. **Check** whether the OVI gives full particulars of the goal, the purpose or the intermediate result. If the answer is **NO**, you should look for a new OVI or add a second (or a third).
4. **Check** whether the lower level OVI lead on to the higher-level OVI.

Example:

For the purpose: "Rice production increased"

- Target group : The farmer (owning at least 0.5 hectares)
- Quantify : 10 000 farmers increase their output by 50%
- Qualify : 10 000 farmers increase rice production whilst maintaining 1983 crop quality
- Time : Before October 1985
- Place : The province of Umbia

For the purpose: "Quality of hospital services improved"

- Target group : Road casualties
- Quantify : 500 casualties
- Qualify : The death rate among casualties falls from 25% to 12,5%
- Time : 1985
- Place : Hospital Y

Sources of verification: Sources of verification are the results of surveys and/or findings which give us the data we need to use the OVI.

The selected indicators should be both SMART and SPICED. See Box 2.1

Box 2.1: SMART and SPICED Indicators

SMART	SPICED
S = Specific	S = subjective
M = Measureable	P = Participatory
A = Action oriented	I = Interactive
R = Relevant	C = Communicable
T = Targeted	E = Empowering
	D = Disaggregated

Description of important elements:

What should we look out for when describing the sources of verification?	It is wise to specify: • Access: Where and when can we find the data? • Who is responsible for the data?
Why do we describe the sources of verification?	To find out what the intervention should do to obtain the data and at what cost.
Where can we find the sources of verification?	Outside the intervention; resources must be found to pay the "owner" of these resources. Within the intervention itself; activities should be planned within the intervention.
What can we do when there is no source of verification for an OVI?	Replace the OVI by another for which there is a source.
What criteria do we have to evaluate the sources of verification?	The sources of verification must supply infallible, reliable and accessible data. The investigation should allow for the fact that verification will demand money, time and manpower. These elements will affect the resource requirements and the budget.

Steps for determining the sources of verification:

1. Determine which sources of verification are needed to collect the necessary data for the OVI.
2. With regard to sources of verification identified outside the scope of the intervention, consider:
   (a) Whether they have been put in the proper form.
   (b) Whether they are specific enough as to region and target group.
   (c) Whether they are reliable, accessible and up to date.
   (d) Whether the source is accessible (where and when?)
3. Identify the sources of verification which must be collected, processed and stored by the intervention itself.
4. Replace any indicators for which no suitable sources of verification have been found by other indicators.

Resources (inputs): Resources comprise the (human and physical) input thanks to which the intervention will be able to carry out its activities.

Description of important elements:

What kind of resources do we work with?	**Human resources**: National staff, expatriate development worker and scholarship students. **Investment (or production) resources**: There are assets which cover several production cycles and for which a depreciation allowance must be made. Working capital is regarded as an investment resource. **Operating resources** are resources which can be used only once, since they are destroyed (ie. seed) or transformed (ie. raw materials, fuel, incidental expenses) in the process.
Where do these resources come from?	There are three possible sources: • The donor. • The developing country institutions. • The intervention itself.
How do we formulate these resources?	• In qualitative and in quantitative terms. • We indicate the time frame for the intervention. • In financial terms.
How do we classify these resources?	In two categories: • Specific resources: Resources linked to the activities mentioned in the logframe (these resources are se out in forms annex 1). • Global resources: Resources linked to the backup and administration activities not listed in the logframe.

Steps for determining the resources:

1. Determine the specific resources, ie. the resources needed for each of the activities arising from the logframe:
   - Human resources: set down quality and number of men/month (m/m)
   - Production (investment) resources: Set down the type (of machine), the number and if applicable, how long they can be used (depreciation allowance).
   - Operational resources: Set down the type (of asset) and the number (ie. diesel fuel for a 4x4 to cover 10 000 km).
2. Determine the global resources, ie. the resources linked to the back-up and administration activities not included in the logframe, ie. a head office, administrative resources (management, accounting).
3. Classify the resources by budget source: The donor or the developing country institutions.
4. Specify the specific resources in the form called “cost of specific resources per activity” (Annex 1); you should use a separate form for each activity.

Put together the cost of activities for each intermediate result using the form called “cost of specific resources per intermediate result.

Put together the cost of the intermediate results, intervention by intervention, using the top half of the form called “cost of specific and global resources per intervention” (Annex 3).

Put together the cost of global resources for the intervention using the bottom half of the form called “cost of specific and global resources per intervention” (Annex 3).

Insert both grand totals shown in Annex 3 into the logframe (column OVI, item “activities”).

Financial requirements: This is the posting of requisite human and physical resources in financial terms, broken down by origin: The donor, the developing country or the intervention itself.

Description of important elements:

What kind of costs do we work with?	We differentiate between foreign currency and local currency.
Where do the financial resources come from?	There are three possible sources of finance: • The donor. • The developing country's budget. • The intervention itself.
How should the financial requirements be classified?	By specifying: • The financial sources. • The financial (budget) years.

Steps for determining the cost of the intervention?

Indicate:

Details of the financial requirements on the appropriate form, using

- The form called "cost of specific resources per activity" (Annex 1)
- The form called "cost of specific resources per intermediate result" (Annex 2)
- The form called "cost of specific and global resources per intervention" (Annex 3)

The grand totals of financial requirements per source, in the column "sources of verification", item "activities" (these are also listed in the form called "cost of specific and global resources per intervention" - Annex 3)

Own income of the intervention

Interventions will also generate their own income (ie. by selling services and/or products). Intervention income, together with cost, will determine the intervention's financial profitability. This will feature in the financial feasibility study.

The Advantages of LFA as a Planning Tool

The LFA has the following advantages:

- It tries to make the project appraisal transparent by explicitly stating the assumptions underlying the analysis, and by allowing a check on the proposed hypotheses and expected results in an ex-post analysis;
- It deals explicitly with a multitude of social goals and does not require the reduction of the benefits into one figure;
- It is understandable to non-scientists. The logframe, therefore, can be used as a tool to clarify trade-offs, and thus, to ameliorate the decision-making process; and
- It is flexible with regard to information and skill requirements. It can incorporate social benefit – cost analysis, use input-output tables, and partial models. But it can also be used with rudimentary information skills, albeit of the cost of more hypothesis and uncertainties.

Thus, a log frame enables planners to:

- Set clear objectives.
- Define indicators of success:
  - Performance standards.
  - Incorporate change over time.
- Clarify logical linkages in the plan.
- Define critical assumptions underlying the project.
- Identify key activity groups.
- Identify means of verifying project accomplishments.
- Define resources required for implementation.
- Set up a need-based monitoring and evaluation system.

Data needs: Based on the indicators identified, the data needs should be established. Data collection should be built in as a regular part of the on-going delivery activities. Decisions should be made on data collection methods, including timing, frequency, and who will collect the data. Data alone are not very useful. They need to be organised, analysed, and interpreted so that conclusions can be drawn on how well the projects are performing, and possibly recommendations made.

A Few Tips on Measuring Results and Performance: We measure performance to learn and improve. Performance measurement helps us to understand what is working and what is not. It is essential to the process of continuous improvement, ie. provides a basis to take appropriate corrective measures. Developing evaluation measures should be a participatory exercise, and should measure both efficiency and effectiveness. Measuring the process may be useful to help us achieve greater efficiency, but this is of little value without effectiveness measures that focus on clients and impacts. In particular, we should look for the change in client behaviour that usually precedes economic impact.

However, too many measures are no better than too few. We cannot measure everything, therefore, it is best and more practical to focus only on a limited number of key result indicators. Start “small” and then make appropriate adjustments to improve the process. It may be wise and efficient (cost effective) to start with a limited number of measures, then refine them and add new ones in order to build a measurement system progressively. One should look at immediate impact, medium (intermediate) term impact, and long-term/ultimate impact in terms of the initial operational targets, which may be an exercise that is challenging, but possible.

The initial attempt may be imperfect, but can be refined as experience is gained. Measuring performance costs time and money, but not measuring performance may cost more. In addition, one cannot show with any credibility, what is being achieved nor can one "fix” what is not working well.

Two “acid tests” for the quality of a performance measurement system are:

- Assuming the degree of congruence between its objectives and its impact statements.
- Simple observation of the use that is made of the performance information. A high degree of use may be a signal that the measures are right, ad that the performance information being generated is appropriate to the decision at hand.

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PROJECT APPRAISAL THROUGH COST-BENEFIT ANALYSIS

Introduction

In the appraisal stage of the project planning process the optimal use of scarce resources by the proposed project intervention will be appraised by using Cost-Benefit Analysis (CBA) methodology. Cost-Benefit Analysis represents a framework where all project benefits and costs are identified, quantified, valued and compared against a range of optimality criteria on an *ex-ante* (before project) basis. CBA can also be used as an *ex post* (after project) evaluation method.

CBA analysis determines the economic efficiency of a project. Whereas the CBA methodology recognises the importance of the indirect and external impacts, it focuses on direct benefits and costs. Through the application of "economic shadow pricing" methods, secondary effects, multipliers and linkages are accounted for in the analysis.

Historical evolution of cost-benefit analysis methodology

Cost Benefit Analysis compare project induced benefits with project costs. The United States (U.S.) federal water agencies and the U.S. Army Corps of Engineers, were among the first to make use of Cost-Benefit Analysis technique (1940-50's). From an economic point of view these methods were elementary in the sense that only direct financial project costs were compared with the calculated expected financial increases in direct production. The time value of benefits and costs and risks was not assessed, nor were the wider economic and social impacts. Economic efficiency was also not considered. Optimal resource allocation could thus not be assessed. During the nineteen sixties the cost-benefit method was fine-tuned to include the concept of time value (discounting) of cost and benefit streams. However, the analysis was still mainly financial, because the value of cost and benefits streams was measured according to market prices. During this time projects were popularly viewed as the *"cutting edge"* for development investment, especially in agricultural development efforts. Prices were also increasingly distorted through government intervention and/or market manipulation. Market prices alone could not account for the true economic value of benefits and costs. The need for a social cost-benefit technique therefore emerged which could identify the total and real economic impact or consequences of a development project. This led to the development of methods based on the *"new orthodoxy"*, ie. the assessment of a project from business, economic and social viewpoints. These methods differed from the conventional CBA method in that the market prices, used in the business analysis, were not necessarily accepted as real value indicators for the economic impact. Shadow prices based on economic efficiency were rather used. This gave rise to the methodology of socio-economic Cost-Benefit Analysis, which will be discussed in this chapter.

The Nature of Cost-Benefit Analysis (CBA)

The CBA methodology compares project benefits and costs. Benefits are all activities which contribute to the value of the project objective and costs reduce the value of the objective.

CBA provide a framework to analyse project effects measured from different viewpoints, *viz* private, public, economic, social. This method also provides the scope for dealing with the various forms of market distortions and efficiency considerations.

Private sector and public sector investment

Projects can be funded by private business initiatives or through the public sector (government/parastatal). In some cases both sectors contribute. This is normally the case with agricultural development projects.

When a private institution evaluates the merit of different project investment options, then it is through a Financial Analysis. The first step in this analysis is to ensure that all the projects are feasible at the technical level. After this the analysis applies capital budgeting and financial analysis techniques to ensure that the project will be financially profitable, in other words that it will contribute to increasing the net value of the business. The net value is the surplus of assets over liabilities as reflected in the balance sheet. In order to contribute to the net value, it is necessary for the project to be profitable. Analysis will therefore discount the expected stream of profits and/or losses to the present in order to determine the effect on the net value.

In the public sector (with the exception of the government business undertakings and public corporations which have to break even) profit is not the main objective. Public investment is rather directed towards public and social services and actions which will enhance the environment in which business will attempt to make profits, but which is too expensive or of a long-term nature to attract private investment. A variety of analyses of such investments should therefore be carried out in place of profit determination, one of which, for example, amounts to an analysis of the source and application of productive resources with the aim of determining whether the use of the limited resources is economically efficient. Here the analysis is carried out considering the economic cost to produce economic benefits to the Society at large – often called Economic Analysis. Since the objectives of the processes of profit determination and of the analysis of efficient resources application differ, there are important differences between the two methods of analysis. These include:

Depreciation: With profit determination, depreciation is accounted for by the systematic write-off method because it reduces gross profit, while in the case of the source and application of funds (economic analysis) depreciation is not taken into account, since it effects both the source and application of funds;

Income tax: Income tax is included in profit determination but excluded from the determination of the economic analysis since it does not directly contribute to a more effective or less effective application of funds.

Interest: Interest payments are included in profit determination but excluded from the economic analysis, because they do not influence the efficiency of conversion of inputs into outputs, and can therefore be considered merely a transfer payment.

There are certain aspects, however, which are considered neither in profit determination nor in the measurement of intangible advantages and disadvantages and the distribution of advantages and costs. For this it is necessary to carry out an analysis comparing all benefits and costs – so-called **Social Analysis**.

A project with components of private sector involvement and public sector investment thus require a comprehensive **cost-benefit analysis** which should include the following:

- The financial assessment, to determine the business prospects and a project's need for funds and also whether the project is viable from a financial point of view;
- the economic analysis, to determine the scarcity value or the economic efficiency of goods and services used in the project and arises from the project; and
- the social analysis, which is an investigation into the overall effects of the project on the distribution of welfare and other social circumstances.

Project analysis from different viewpoints: financial, economic and social analysis

The financial analysis component of CBA is used as a fairly standard practice in the public and private sectors and this sourcebook therefore does not expand in any detail on it. This chapter focuses mainly on the economic analysis. As regards the social analysis, aspects are addressed but not quantified. This aspect, i.e. quantification is controversial, albeit important.

(i) Financial analysis

Financial analyses focus on the business prospect of a project. The term "financial analysis" can, depending on the context in which it is used, refer to one or more accounting techniques, e.g. cash-flow analysis, profit determination, or the analysis of the source and application of funds. "Financial analysis" as used in this chapter refers to a cash-flow analysis from which present and future expenditure and income are calculated to determine the financial feasibility of a project. The analyses are done at market prices. In the case of public projects such as analysis normally gives an indication of the pressure the project will place on the exchequer, ie. the fiscal requirements and the degree of subsidisation it will require. Financial analysis is also called private analysis where costs and benefits are considered from an individual's or business point of view.

Some aspects related to financial analysis are discussed here.

Financial analysis is carried out for different purposes:

- Assessment of financial impact:
    - Financial effect on farmers, public and private firms and any other participating agencies. For each, examine the current financial status against the projection of future financial performance.
- Efficiency of resource use:
    - Return of project investment and repayment of loans capacity;
    - Profitability of individual enterprises.
- Assessment of incentives:
    - Assess incentives for farmers, managers, and other participators and beneficiaries to participate;
    - For farmers, is incremental income enough to justify change?
    - For private firms, is it profitable enough for them to make the required investments?
    - For parastatals, is the return large enough to be self-financing?
- Financial plans:
    - Identify sources of funds - amount, timing, repayment terms and conditions of credit for individual entities; and
    - Effect of inflation.
- Financial contributions:
    - Co-ordinate contributions from various sources and match investment requirements.
- Assessment of financial management competence:
    - Assessment of complexity of financial matters and therefore managerial requirements;
    - Assess any changes in organisation and management that are necessary; and
    - Identify any special training required.

Two important aspects of financial analysis are discussed here. The farm budget analysis and the analysis required to reach a farm level investment decision.

Farm Budget Analysis is the beginning of financial analysis

- As the starting point of financial analysis this usually involves representative farm models. Based on patterns of representative farms these models generate enterprise (crops and livestock) budgets to compare the situation “with-the-project” to that of “without-the-project”.
- Farm budget analysis assesses benefits and incentives.
- Farm budget analyses is static, i.e., one year and is useful to help improve management. In farm budget analysis:
    - Current prices are used, depreciation included;
    - Non-cash items are included; and
    - Off-farm income is excluded.

Farm Investment Analysis support decisions to:

- Determine the attractiveness of investment;
- Uses discounted cash flows;
- Dynamic - over life of project; and
- Off farm income is included.

Farm budgets, e.g., gross margin budgets are a useful starting point, but need to be adjusted, especially with respect to depreciation. With adjusted budgets, it is easy to calculate real fund flow.

(i) Economic analysis

This analysis determines the economic efficiency of resource use in a project. By economic analysis is meant that project benefits and costs are evaluated at prices which reflect the relative scarcity of inputs and outputs. The financial analyses normally follow the analysis of the source and application of productive funds, which is done at market prices. However, in the economic analysis prices used to value benefits and costs represent opportunity costs and reflect the actual economic value of inputs and outputs. The opportunity cost is the value of the best alternative application of an input or an output of the project. The market price of land, for example, does not necessarily reflect the opportunity cost of the land. Thus, when a price has to be determined, in the economic analysis, for example, for a piece of agricultural land used for maize farming but on which an airport is planned, the opportunity cost of the land is the discounted net output from the maize. Prices in the economic analysis are referred to as “shadow prices”.

The calculation of shadow prices as a substitute for market prices are set out in more detail in Section 4.4.

(ii) Social analysis

This analysis aim to determine the consequences of a project for the distribution of welfare. An appraisal can also be made of the effects of other social factors such as equity and gender aspects.

Table 3.1 summarises the different viewpoints and dimensions of project analysis.

Table 3.1: Dimensions of Project Analysis

Cost-benefit analysis in the public sector and profit determination in

BUSINESS VIEWPOINT:	GOVERNMENT VIEWPOINT:	SOCIETY AT LARGE:
▪ Impact on those directly involved: farmers, financiers, project developers. ▪ Decision criteria: financial profit, cash flow, equity. ▪ Market prices and direct impacts. ▪ Market interest rates, depreciation, tax, inflation, etc.	▪ Fiscal focus: outflows vs inflows (fares, etc.) Tax (income) ▪ Annual government budget criteria. ▪ Affordability and national priority.	▪ Economic efficiency and distributional impacts. ▪ Shadow pricing. ▪ Time periods present vs future generations.
FINANCIAL ANALYSIS	FISCAL ANALYSIS	ECONOMIC & SOCIAL COST-BENEFIT ANALYSIS

the private sector

Important differences exist between cost-benefit analysis in the public sector (economic analysis) and profit determination in the private sector (financial analysis). The first is to be found in the fact that the private enterprise is concerned only with the interests of its owners or shareholders when profits are being calculated, while economic efficiency and the interests of society and the economy at large are the focus of cost-benefit analysis. The result is that a much wider spectrum of costs and benefits has to be considered than in the case of pure profit determination. Consider, for example, a new transport system linking an agricultural project to the market, which is cheaper and also provides transport for a part of the population, but entails environmental costs in the form of air and noise pollution. The latter aspects would be ignored in the determination of profits in the private sector, but will be taken into account in a cost-benefit analysis as part of the cost that society must bear.

In the second place cost-benefit analysis differs from profit determination in that all variables in the latter case are measured in terms of market prices, while the economic value and social benefits in the former case are often provided at subsidised prices so that the market prices of inputs and outputs, where they exist, are distorted and do not reflect the actual economic and/or opportunity costs and benefits. Because, as has been mentioned, CBA utilises opportunity costs, market prices have to be adjusted to reflect the actual economic value of costs and benefits.

The third important difference between cost-benefit analysis and the determination of profits as applied in the private sector, is in the rate used in the process where future benefits and costs are discounted to present value, ie. the discount rate. While the discount rate in the case of profit determination is a market-related rate which reflect the market cost of funds as well as uncertainties and risk, the discount rate used in cost-benefit analysis represents the time preference of society and is referred to as the social time-preference rate. This rate is normally lower than the market-related rate.

The most important differences between cost-benefit analysis in the public sector and profit determination in the private sector are summarised in Table 3.2.

Table 3.2: Differences between cost-benefit analysis in the public sector and profit determination in the private sector

Nature of difference	Cost-benefit analysis – Economic Analysis	Profit determination/ Financial Analysis
1. From the point of view of	Community/society/economy	Shareholder/Individuals
2. Objectives	Apply scarce resources effectively and economic efficiently	Maximise net value of firm – Private Profit
3. Discount rate	Social time-preference rate	Market rate or weighted marginal cost of capital plus uncertainty and risk premium
4. Value unit:	Opportunity cost	Market price
5. Dimensions	All aspects necessary for a rational decision	Limited to aspects of decision-making that may affect profits/losses of individuals
6. Externalities	Included	Excluded
7. Social impacts and intangibles	Can be examined and weighed	Excluded
8. "Advantages"	Additional goods, services, products, income and/or cost savings included in analysis	Only money income and profit determination
9. "Disadvantages"	Opportunity costs in terms of goods and services foregone, which is difficult to determine accurately.	Money payments and depreciation calculated according to accounting principles

Financial and economic values: Financial analysis of a project evaluates the project from a private investor's point of view. It aims to determine commercial profitability, and only inputs and outputs that enter this objective function are included in the calculation at prevailing marker prices. Financial prices are the prices people actually pay, and concern evaluation using domestic market prices expressed in domestic currency.

Economic analysis evaluates the benefits and costs of a project from society's point of view, which is what the government should be concerned with. It presumes that commercial profitability may not adequately value the project from a social welfare point of view. Economic prices are the values that society would be willing to pay for a good or a service, and concerns the real net national income change valued at opportunity cost. Where economic distortions occur financial and economic values will differ – in some cases quite considerably.

Divergences in financial and economic values can be attributed to various factors:

- Market "failure", due to monopolies, external economies, incomplete information, public and quasi-public goods, the paradox of thrift, and fallacies of composition;
- Government intervention or police "failures", due to inappropriate, insufficient, or excessive interventions to correct market failures or interventions which disrupt otherwise efficiently functioning markets and causes distortions in markets and market prices. This generally involves two types of distortions, viz **border** distortions which include export subsidies and import bans, and the tendency to sustain an overvalued exchange rate, and **domestic** distortions such as direct subsidies and other interventions which affect relationships among domestic prices;
- Merit and demerit goods.

These aspects are discussed in detail in the subsequent sections and in the Annexure 1 (Fundamental concepts and theoretical consideration of cost-benefit analysis).

Considerations and application of cost-benefit analysis

Cost-benefit analysis is aimed at assessing the costs and benefits of alternative investment projects or program expenditures on a comparable basis as far as possible, especially through the use of a common value measuring instrument, namely prices that are determined on a consistent basis. In this way the problem of choosing between alternative projects is simplified, since qualitative arguments for or against a certain project are backed up by numerical criteria. The central problem with cost-benefit analysis arises from the question of quantification.

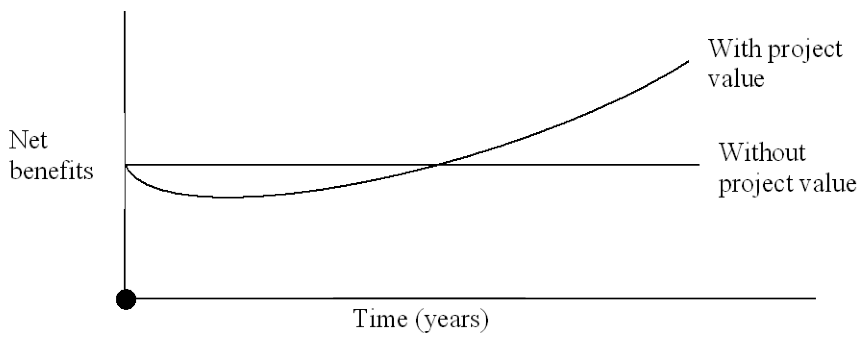
The following aspects among others should be kept in mind when applying cost-benefit analysis:

(i) **Framework of reference:** Cost-benefit analysis in reality constitutes a particular conceptual model which can be viewed as an analytical model or "framework of reference", which represents a simplified version of reality. Through the application of the framework the decision-maker is guided to think through the full repercussions of the investment decision. This prevents people from misunderstanding each other and thus increases the objectiveness and effectiveness of decision-making.

(ii) **Pareto principle:** Cost-benefit analysis is a technique used in an attempt to bring about a more effective allocation and distribution of scarce resources. The criterion in this case is the achievement of what is referred to as Pareto optimality, which indicates that at least one person in society is better-off while no one is worse-off. A necessary prerequisite here is that the social benefits of the proposed project should exceed the social cost. The central role that the Pareto principle plays is to ensure that cost-benefit analysis is aimed at distributional effectiveness. It should also be ensured that a given objective/goal is achieved with the application of the fewest resources possible by carrying out cost-effectiveness studies. Until now attempts to find a single criterion which covers all the essential aspects of importance in a decision on a project have not been very successful. Where possible, therefore, the Pareto criterion must continue to be supplemented with additional criteria and additional analyses. These include performance auditing, perception auditing, utility studies, impact studies, operational research and systems analysis, organisational analysis, sensitivity analysis, etc.

(iii) **"With" and "without" comparisons:** Project analysis attempts to identify and value the costs and benefits that will arise with the proposed project and to compare them with the situation as it would be without the project. The difference is the incremental net benefit arising from the project investment. This approach is not the same a comparing the situation "before" and "after" the project. The before-and-after comparison fails to account for changes in production that would occur without the project and thus lead to an erroneous statement of the benefit attributable to the project investment (see Figure 3.1)

Figure 3.1: Schematic Representation of with and without project situations



A change in output without the project can take place in two kinds of situations. The most common is when production in the area is already growing, if only slowly, and will probably continue to grow during the life of the project. The objective of the project is to increase growth by intensifying production. In this case, if the project analyst had simply compared the output before and after the project, he would have erroneously attributed the total increase in production to the project investment. Actually, what can be attributed to the project investment is only the incremental increase in production that would have occurred anyway.

A change in output can also occur without the project if production would actually fall in the absence of new investment. The benefit from this project, then, is not increased production but avoiding the loss of agricultural output. A simple before-and-after comparison would fail to identify this benefit. The *"with-out"* project scenario would therefore require the same quality of preparation as the *"with"* project proposal.

(iv) **Sensitivity analysis:** In the nature of things cost-benefit analysis is aimed at decision-making in respect of projects to be undertaken in the future and therefore involves projections and assumptions regarding future developments. This implies that an uncertainty boundary will necessarily exist affecting decisions in respect of the future taken on grounds of this methodology. It is therefore desirable that cost-benefit analysis should, where necessary, be supplemented by sensitivity analysis i.e. the analysis of risk and uncertainty, as well as additional information relating to these. The specific criteria used to rank alternative projects should be supplemented with sensitivity analysis to show the effect of possible alterations in chosen parameters.

(v) **Scope and focus of CBA:** Cost-benefit analysis is not equally suitable for all projects and therefore it is important to clarify the type of expenditure programs (current as well as capital) on which cost-benefit analysis can be performed. Many experts believe that cost-benefit analysis is particularly useful in the fields of agriculture, natural resource projects (i.e. dams), infrastructure and industrial development, but the latest studies indicate that it can be applied to almost any field. In those situations where cost-benefit analysis is not readily applicable, there is a need for cost-effectiveness analyses so that the decision-maker can be sure that objectives are achieved with the use of the minimum resources. Even with the field of application clearly described, the information which the analysis provides is not always sufficient for the decision which has to be made in the public sector. This is because different national economic objectives of a strategic or political nature will not necessarily always be reconcilable.

In any cost-benefit analysis the ranking of alternative projects or programs according to certain criteria must be supplemented with the results of all other analyses, apart from economic and social analyses, and all of these must as far as possible be quantitatively evaluated. In addition, qualitative analysis should be done where quantification is not possible. All the impacts and consequences of a project should thus be pointed out in sufficient detail to promote "optimal" decisions concerning the project. At times Quantitative Analysis may reflect false accuracy. In the final analysis both objective and subjective criteria should be used to make the decision. The qualitative analysis should complement the quantitative analysis.

(vi) **Wider or secondary considerations:** An important aspect of the application of cost-benefit analysis is that the wider or secondary economic impact of the projects under review outside the immediate sphere of influence of the project, i.e. factors such as consequences for the balance of payments or potential for employment creation, are left out of account or must be evaluated independently. In cases where such limitations apply to the field of influence, reference is made to cost-benefit analysis on the grounds of partial equilibrium analysis. On the other hand, the evaluation of the consequences, if significant, for the price levels, production or structure of large parts of the economy which lie outside the fields directly affected involves general equilibrium analysis as embodied, for example, in structural economic models, input-output models and semi-input-output models. Such models comprise comparisons which expose the relationships between key variables so that the effect of primary and secondary variations in a single variable against other variables can be determined. The model which is at the moment enjoying the most research and development attention is the input-output based Social Accounting Matrix model. The multipliers calculated from this model can also be used to provide indications of the linkage effects of projects. In this way, for example, the full consequences for the demographic structure, the labour force and distributional aspects of a development project can be studied.

Some analysts make these secondary consequences an integral part of the costs and benefits of the project and reflect them in the decision-making criteria of cost-benefit analysis. The desirability of this is questionable, and the multiplier effect should rather be shown separately to avoid any double counting. In the economic analysis, the evaluation of primary costs and benefits is sufficient mainly because opportunity costs to some extend already include the multiplier effects. Unfortunately, the boundaries between projects with negligibly small effects on macro-variables, which could readily be accommodated by opportunity costs and projects which exert fundamental effects on such variables are often difficult to determine and rational decisions depend on the sound judgement of the analyst.

(vii) **Data requirements:** It must be emphasised that reliable statistics and a data base are very important to the implementation of a system of cost-benefit analysis. Generating such data may however be costly. In some situations a project below a certain cost value may not justify the cost of a comprehensive CBA.

From the above discussion it is clear that the methodology and an accurate application of cost-benefit analysis requires not only technical skill, but also a broad economic knowledge, profound insight and a clear-headed approach to problems. It is particularly important that the key aspects that are essential to the reaching of sound decisions should be separated from secondary information, of which note should also be taken. Exceptional expert knowledge, insight and experience are therefore needed for the successful application of the technique along with complementary methodology. In spite of the limitations mentioned, no single method normally provides more satisfactory results than cost-benefit analysis. Thus it has widely used in decision making i.e. resources allocation among competing alternatives.

A step-by-step approach to cost benefit analysis

The CBA framework is designed to translate data and information into a financial analysis. After the financial analysis is completed, data is transformed into an economic analysis. The transformation is achieved by the following sequence of steps in the analysis:

- Specify the “with” and “without” situations.
- Estimate the physical consequences over time.
- Determine costs/benefits on physical consequences in order to derive cash flows over the life of the project.
- Discount cash flows at market rates in order to derive measures of discounted project worth, ie. IRR, NPV, etc.
- Transform financial analysis into economic analysis by redoing all the steps above with the following modifications.
- Adjust for transfer payments.
- Use social opportunity costs/benefits.
- Discount at the social discount rate.
- Do sensitivity analysis.
- Explore social impacts and intangibles.
- Prepare a report to support decision-making.

The application of CBA is summarised below and considered in more detail in the next chapter.

STEP 1: Specifying “with” and “without” situations

Specifying “with” and “without” situations is discussed in greater detail in 3.4 (iii)

STEP 2: Estimating costs and benefits over time

Estimate physical consequences as benefits and costs over time in order to derive cash flows in the next step. Physical sources have to be identified in the form of physical inputs and outputs over time to cover the life of the project.

Start with a list of benefits and costs, and then estimate the quantities of each for each year. **Important**: please note that a separate list is required for the “with” and “without” situations.

Examples of benefits and costs of agricultural projects:

- Costs:
  - Physical production inputs;
  - Labour;
  - Land;
  - Contingency allowances;
  - Taxes; and

- Debt service, interest on capital cost of financial, cost on economic.

- Benefits:
  - Tangible benefits:
    Increased production;
    Improved quality;
    Time and location of sale;
    Processed products;
    Reduced costs (transport, mechanise); and
    Reduced loss.
  - Intangible benefits:
    New jobs created by the project;
    Better health, reduced mortality; and
    National integration.

STEP 3: Value determination of costs and benefits

By applying prices to physical inputs and outputs in each time period, allows for derivation of benefits and costs. By deducting costs from benefits in each time period, net benefits are derived. This is done separately for the "*with*" and "*without*" situations.

	Year 1	**Year 2**	**Year 3**	**Year 4**
Costs	$C_{11}, C_{21}, C_{31}, \ldots C_{i1}$	$C_{12}, C_{22}, C_{32}, \ldots C_{i2}$	$C_{13}, C_{23}, C_{33}, \ldots C_{i3}$	$C_{1n}, C_{2n}, C_{3n}, \ldots C_{in}$
Benefits	$B_{11}, B_{21}, B_{31}, \ldots B_{i1}$	$B_{12}, B_{22}, B_{32}, \ldots B_{i2}$	$B_{13}, B_{23}, B_{33}, \ldots B_{i3}$	$B_{1n}, B_{2n}, B_{3n}, \ldots B_{in}$
Net Benefits	$N_{11}, N_{21}, N_{31}, \ldots N_{i1}$	$N_{12}, N_{22}, N_{32}, \ldots N_{i2}$	$N_{13}, N_{23}, N_{33}, \ldots N_{i3}$	$N_{1n}, N_{2n}, N_{3n}, \ldots N_{in}$

Deduct net benefits "*without*" project from the benefits "*with*" project in order to derive annual incremental net benefits (INB).

STEP 4: Discount incremental net benefit

Discount incremental net benefit at the market rate to obtain the present values. Determine appropriate measures of project worth to assist in comparing benefits and costs: net present value (NPV), internal rate of return (IRR), etc.) These concepts are discussed in subsequent chapters.

STEP 5: Transform financial analysis to economic analysis

Transform financial analysis to economic analysis by the following:

STEP 5.1: Adjust for transfer payments. Deduct all taxes and loan services, and add all subsidies.

STEP 5.2**:** Adjust unit prices of inputs and outputs so as to reflect social value. Shadow prices are used where market imperfections and government control results in prices that do not reflect opportunity cost and/or value to society. This usually applies to cost of land, labour, foreign exchange, and goods and services produced or provided under monopolistic conditions.

STEP 5.3**:** Adjust for externalities and spill-overs. Here benefits and costs that occur outside the project as a result of the project are accounted for.

STEP 5.4**:** Discount INB at the social discount rate. For economic analysis the social discount rate is applied, as market rates are usually higher than the social time preference rate. Derive appropriate measures of project worth: NPV, IRR, etc.

STEP 6: Conduct a Sensitivity analysis

To address risk and uncertainty, a sensitivity analysis is performed. The analysis involves adjusting values and prices of physical inputs and outputs on the basis of estimated probability of such variation, and redoing the whole analysis.

STEP 7: Explore social impacts and intangibles

Social impacts and intangibles are usually not included in the calculation. Here, include effects of the project on income distribution, social integration, employment, health, nutrition, etc.

STEP 8: Write up report to support decision-making

The whole analysis and sensitivity analysis is written up to allow appraisal, review and decision-making by other professionals, decision-makers, and financiers.

The step wise approach to project analysis is summarised in Table 3.3.

Table 3.3: A Step-by-step approach to CBA

Step 1	Specify with and without project situations
Step 2	Describe costs and benefits over the project period
Step 3	Determine the value of cost and benefits
Step 4	Discount project values
Step 5	Transform financial analysis to economic analysis
Step 6	Conduct a sensitivity analysis
Step 7	Explore social impact and intangibles
Step 8	Write up report to support decision-making

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THE APPLICATION OF COST-BENEFIT ANALYSIS METHODOLOGY

Introduction

We undertake economic analyses of agricultural projects to compare costs with benefits from an efficiency viewpoint and determine which among alternative projects have an acceptable return. The costs and benefits of a proposed project therefore must be identified. Furthermore, once costs and benefits are known, they must be priced and their economic values determined and compared. All of this is obvious enough, but frequently it is a tricky business.

Knowledge about what costs and benefits are relevant with respect to the agricultural sector, and how these can be defined valued and compared in a consistent manner, are the topics of this chapter. These aspects are discussed in the following sections:

Identifying and Describing Project Costs and Benefits

Objectives, costs and benefits

In project analysis, the objectives of the analysis provide the standard against which costs and benefits are defined. A cost is anything that *reduce* an objective, and a benefit is anything that contributes to an objective (refer to Chapters 2 and 3).

The problem with such simplicity, however, is that each participant in a project has many objectives. For a farmer, a major objective of participating in a project is to maximise the amount his/her family has to live on. A farmer may have an objective to avoid risk and so may plan his cropping pattern to limit the risk of crop failure to an acceptable level or to reduce the risk of depending solely on the market for the food grains the family will consume. All these considerations affect a farmer's choice of cropping pattern and thus the income-generating capacity of the project.

For private business firms or government corporations, a major objective is to maximise net income, yet both have significant objectives other than simply making the highest profit possible.

A society as a whole will have as a major objective of increased national income, but it clearly will have many significant, additional objectives. One of the most important of these is income distribution. Another is simply to increase the number of productive job opportunities so that unemployment and poverty may be reduced – which may be different from the objective of income distribution itself. Any of these objectives might lead to the choice of a project that is not the alternative that would contribute most to income narrowly defined.

No formal analytical system for project analysis could possibly take into account all the various objectives of every participant in a project. Some selection will have to be made.

For farms, we will take as the objective maximising the incremental net benefit – the increased amount the farm family has to live on as a result of participating in the project.

For a private business firm or corporation in the public sector, we will take as the objective maximising the incremental net income and/or net worth. And for the economic analysis conducted from the standpoint of the society as a whole, we will take as the objective maximising the contribution the project makes to the national income – the value of all final goods and services produced during a particular period, generally a year. It is important to emphasise that taking the income a project will contribute to a society as the formal analytical criterion in economic analysis does not downgrade other objectives or preclude our considering them. Rather, we will simply treat consideration of other objectives as separate decisions. Using this analytical system, we can judge which among alternative projects or alternative forms of a particular project will make an acceptable contribution to national income. This will enable us to recommend to those who must make the investment decision a project that has a high income-generating potential and also will make a significant contribution to other social objectives. Thus a multi criteria analysis is often used to facilitate resource allocation.

Therefore, in the system of economic analysis discussed here, anything that reduces national income (the objective) is a cost and anything that increases national income is a benefit. Since our objective is to increase the sum of all final goods and services, anything that directly reduced the total final goods and services is obviously a cost and anything that directly increases them is clearly a benefit.

If this rather simple definition of economic costs and benefits is kept in mind, possible confusion will be avoided when shadow prices are used to value resource flows.

Costs of agricultural projects

In almost all project analyses, costs are easier to identify (and value) than benefits. In every instance of examining costs, we will be asking ourselves if the item reduces the net benefit of a farm or the net income of a firm (objectives in financial analysis), or the national income (objective in economic analysis),

- **Physical goods:** Rarely will physical goods or inputs used in an agricultural project be difficult to identify. For goods such as concrete for irrigation canals, civil works, fertiliser and pesticides for increasing production, or materials for the construction of homes in land settlement projects, it is not the identification that is difficult but the technical problems in planning and design associated with finding out how much will be needed and when.
- **Labour:** The labour component of agricultural projects will not be difficult to identify. From the highly skilled project manager to the farm worker maintaining the orchard while it is coming into production, the labour inputs raise less a question of what than of how much and when.
- **Land:** By the same reasoning, the land to be used for an agricultural project will not be difficult to identify. It generally is not difficult to determine where the land necessary for the project will be located and how much will be used.
- **Contingency allowances:** In projects that involve a significant initial investment in civil works, the construction costs are generally estimated on the initial assumption that there will be no modifications in design that would necessitate changes in the physical work. In general, project cost estimates also assume that there will be no relative changes in domestic or international prices and no inflation during the investment period. It would clearly be unrealistic to rest project cost estimates only on these assumptions of perfect knowledge and complete price stability. Sound project planning requires that provision be made in advance for possible adverse changes in physical conditions or prices that would add to the baseline cost. Contingency allowances are thus included in a regular part of the project cost estimates.

  Inflation, however, poses a different problem. In project analysis the most common means of dealing with inflation is to work in constant prices, on the assumption that all prices will be affected equally by any rise in the general price level. This permits valid comparisons among alternative projects. If inflation is expected to be significant, however, provision for its effects on project costs needs to be made in the project financing plan so that an adequate budget is obtained.
- **Taxes:** Recall that the payment of taxes, including duties and tariffs, is customarily treated as a cost in financial analysis but as a transfer payment in economic analysis. It is thus not viewed as a cost in the economic analysis. The amount that would be deducted for taxes in the financial accounts remains in the economic analysis as part of the incremental net benefit and, thus, part of the new income generated by the project.
- **Debt service:** The same approach as above applies to debt service – the payment of interest and the repayment of capital. Both are treated as an outflow in financial analysis. In economic analysis, however, they are considered transfer payments and are omitted from the economic accounts.
- **Sunk costs:** Sunk costs are those costs incurred in the past upon which a proposed new investment will be based. These costs, however, cannot be accounted for in a CBA. When we analyse a proposed investment, we consider only future returns to future costs: expenditures in the past, or sunk costs, do therefore not appear in the analysis.

Direct and tangible benefits of agricultural projects

Direct and tangible benefits of agricultural projects can arise either from increased value of production or from reduced costs.

(i) **Increased value of production:** This could occur in many ways.

- **Increased production:** Increased physical production is the most common benefit of agricultural projects.

In a large proportion of agricultural projects the increased production will be marketed through commercial channels. In that case identifying the benefit and finding a market price will probably not be too difficult, although there may be a problem in determining the correct value to use in the economic analysis.

In many agricultural development projects, however, the benefits may well include increased production consumed by the farm family itself. The home-consumed production from the project will increase the farm families' net benefit and the national income just as much as if it had been sold in the market. Indeed, we could think of the hypothetical case of a farmer selling his output and then buying it back. Since home-consumed production contributes to project objectives in the same way as marketed production, it is clearly part of the project benefits in both financial and economic analysis. Omitting home-consumed production will tend to make projects that produce commercial crops seem relatively high-yielding, and it could lead to a poor choice among alternative projects. Failure to include home-consumed production will also mean underestimating the return to agricultural investments relative to investments in other sectors of the economy.

- **Quality improvement:** In some instances, the benefit from an agricultural project may take the form of an improvement in the quality of the product. Both increased production and quality improvement are most often expected in agricultural projects, although both may not always occur simultaneously. One word of caution: both the rate and the extent of the benefit from quality improvement can easily be overestimated.
- **Change in time of sale (time utility):** In some agricultural projects, benefits will arise from improved marketing facilities that allow the product to be sold at a time when prices are more favourable.
- **Change in location of sale (place utility):** Other projects may include investment in trucks and other transport equipment to carry products from the local area where prices are low to distant markets where prices are higher.
- **Changes in product form - grading and processing (form utility):** Projects involving agricultural processing industries expect benefits to arise from a change in the form of the agricultural product.

(ii) Reduced Cost

The various ways of reduction in costs of projects are discussed in the following sections:

- **Cost reduction through technology:** The classic example of a benefit arising from cost reduction in agricultural projects is that gained by investment in agricultural machinery to reduce labour costs. Total production may not increase, but a benefit arises because the costs have been trimmed (provided, of course, that the gain is not offset by displaced labour that cannot be productively employed elsewhere).
- **Reduced transport costs**: Cost reduction is a common source of benefit wherever transport is a factor. Better feeder roads or highways may reduce the cost of moving produce from the farm to the consumer. The benefit realised may be distributed among farmers, truckers and consumers.
- **Losses avoided:** In discussing with-and-without comparisons in project analyses (chapter 3), we noted that in some projects the benefit may arise not from increased production but from a loss avoided. This kind of benefit stream is not always obvious, but it is one that the with-and-without test tends to point out clearly. This aspect may be critical for high valued perishable commodities.

(iii) Other kinds of tangible benefits

Although we have touched on the most common kinds of benefits from agricultural projects, those concerned with agricultural development will find other kinds of tangible, direct benefits most often in sectors other than agriculture. Transport projects are often very important for agricultural development. Benefits may arise not only from cost reduction, but from time savings, accident reduction, or development activities in areas newly accessible to markets. If new housing for farmers has been included among the costs of a project, as is often the case in land settlement and irrigation projects, then among the benefits will be an allowance for the rental value of the housing.

Secondary costs and benefits

Projects can lead to benefits created or costs incurred outside the project itself. Economic analysis must take account of these external, or secondary, costs and benefits so they can be properly attributed to the project investment.

Instead of adding on secondary costs and benefits, one can either adjust the values used in economic analysis to account for the secondary costs and benefits in the analysis, thereby in effect converting them to direct costs and benefits. This is the approach taken in most project analyses carried out by international agencies, and in the analytical approach presented in this Sourcebook.

Incorporating secondary costs or benefits in project analysis can be viewed as an analytical device to account for the value added that arises outside the project but is a result of the project investment. In the analytical system every item is valued either at its opportunity cost or at a value determined by a consumer's willingness to pay for the item through the use of shadow prices. By this means we attribute to the project investment all the value added that arises from it anywhere in the society. Hence, it is not necessary to add on the secondary costs and benefits separately; to do so would constitute double counting.

Although using shadow prices based on opportunity costs or willingness to pay greatly reduces the difficulty of dealing with secondary costs and benefits, there still remain many valuation problems related to goods and services not commonly traded in competitive markets.

Another group of secondary costs and benefits often encountered are "technological spill-over" or "technological externalities". Adverse ecological effects are a common example and the side effects of irrigation developments are often cited as an illustrative example of this type. A dam may reduce river flow and lead to increased costs for dredging downstream. When these technological externalities are significant and can be identified and valued, they should be treated as a direct cost of the project or the cost of avoiding them should be included among the project costs.

It is sometimes suggested that project investments may give rise to secondary benefits through a "multiplier effect". The concept of the multiplier is generally thought of in connection with economies having excess capacity. If excess capacity exists, an initial investment might cause additional increases in income as successive rounds of spending reduce excess capacity. In developing countries, however, it is shortage of capacity giving rise to additional benefits through the multiplier. In any event, most of the multiplier effect is accounted for if we use shadow-price at opportunity cost.

It is also sometimes suggested that there is a "consumption multiplier effect" as project benefits are received by consumers. Consumption multipliers are very difficult to identify and value. In any case, they presumably would be much the same for alternative investments, so omitting them from a project analysis would not affect the relative ranking of projects significantly.

In general it is accepted that all secondary effects would be captured through the application of economic shadow pricing of all direct project benefits and costs.

Intangible costs and benefits

Almost every agricultural project has costs and benefits that are intangible. These may include creation of new job opportunities, better health and reduced infant mortality as a result of more rural clinics, better nutrition, reduced incidence of waterborne disease as a result of improved rural water supplies, atmospheric pollution, green house gas effects, national integration, or even national defence. Such intangible benefits are real and reflect true values. They do not, however, lend themselves to valuation. Because intangible benefits are a factor in project selection, it is important that they be carefully identified and, where at all possible, quantified, even though valuation is impossible.

Value Determination of Costs and Benefits

This section focuses on the calculation of values for costs and benefits. This will involve certain observations on scarce resources that can be used for the achievement of economic objectives and on the functioning of markets to determine prices of such resources.

Prices in cost-benefit analysis

Since resources are limited, an important consideration in their application is to find optimal combinations of resources through which the net benefit can be maximised. The value of inputs and outputs depends to a large degree on the level of sophistication of the economy in which prices are determined. Market prices of products and services often do not reflect the actual economic value (scarcity value) of products and services, since government interfere in the operation of product and services markets through, for example, tariff protection, taxes or subsidies. To assess the economic effectiveness of the application of resources within projects, it is, as has been mentioned, essential that the prices of inputs and outputs indicate their scarcity (economic value).

Scarce resources are traded at specific prices, namely market prices. Provided certain conditions are met, market prices are the best criterion upon which the allocation of resources for specific uses can be based. The assumption is that markets are perfectly competitive and that supply and demand determines the prices of inputs and outputs. When the free operation of the markets is interfered with, by for example the restriction or stimulation of either supply or demand or by price interference (through "policy or market" failure or both) market prices does not reflect economic scarcity values and the use of shadow prices becomes necessary. The various valuation terminologies used in CBA are summarised in Box 4.1.

Box 4.1: Valuation Terminologies

Valuation terminology: in valuing goods and services to prevent confusion it is necessary to describe the terms used. In the literature on cost-benefit analysis the terms "shadow prices" and "accounting prices" have different interpretations. Terms in the cost-benefit literature related to shadow prices are defined below to prevent confusion. Although the terminology possibly may not coincide with that which the reader is familiar with, it is important to endeavour to ensure uniformity in concepts for the purpose of this Sourcebook.

- **Market prices:** Market prices are those prices at which products and services actually trade, irrespective of interference in the market, eg the market wages of labour, the price of 2 kg of maize meal, the price of 1 kilowatt-hour of electricity, etc.
- **(Economic) Shadow prices:** Shadow prices are the opportunity costs of products and services when the market price, for whatever reason, does not reflect these costs, ie. is distorted. Examples are shadow wages of labour, where the fact that minimum wages are fixed is taken into account; a shadow price for fuel, where taxes and subsidies are excluded, where the cost of one kg fertiliser is subsidised, where the local price of an agricultural commodity such as sugar is artificially administered above the prevailing world market prices, etc.
- **Accounting prices:** Some writers use "social accounting prices", or "accounting prices" for short, as a substitute for the shadow price concept when a certain type of shadow price is referred to. In this Sourcebook we use the term 'shadow prices' to avoid any further confusion.
- **World prices (c.i.f. or f.o.b. prices):** The world price is the c.i.f. (cost-insurance-freight included) price of imported or locally produced products or services that are internationally traded, or the f.o.b. (free on board) price of exported products or services. These prices reflect the opportunity cost of products and services where the possibility of international trade exists. The c.i.f. price of capital equipment and the f.o.b. price of iron-ore or deciduous fruit are examples of world prices. It is important to consider the transport cost of imported products up to the point where the product is economically applied. The "world price" and "accounting price" concepts are essentially equivalent. The calculations of c.i.f. and f.o.b. prices are shown in Annex 1 (see also section 4.3.4).
- **Shadow exchange rate:** The shadow exchange rate gives the value of the local currency relative to other currencies when there is no intervention in the foreign exchange market through, for example, the pegging of exchange rates or limits on capital flows. The shadow exchange rate is therefore the nominal exchange rate adjusted for the effect of interventions.
- **Surrogate prices:** Surrogate prices are used to value costs and benefits when no market prices exist or where no market price can be determined. Examples are the value of time and the value of a life. The prices can be determined with the aid of the willingness-to-pay principle. The price of, for example, clean air can be derived from what society (as represented by the State) is prepared to pay for combating of air pollution.

Finding the correct market prices

Project analyses characteristically are built first by identifying the technical inputs and outputs for a proposed investment, then by valuing the inputs and outputs at market prices to construct the financial accounts and finally by adjusting the financial prices so they better reflect economic values. Thus, the first step in valuing costs and benefits is finding the market prices for the inputs and outputs, often a difficult task for the analyst.

To find prices, the analyst must go into the market. (S)he must inquire about actual prices in recent transactions and consult many sources – farmers, small merchants, importers and exporters, extension officers, technical service personnel, government market specialists and statisticians and published or privately held statistics about prices for both national and international markets. From these sources the analyst must come up with a figure that adequately reflects the going price for each input or output in the project.

- **Point of first sale and farm-gate price:** In project analysis, a good rule for determining a market price for agricultural commodities produced in the project is to seek the price at the "point of first sale".

  For many agricultural projects in which the objective is increased production of a commodity, the best point of first sale to use is generally the boundary of the farm. We are after what the farmer receives when he sells his product – the "farm-gate" price.

  In projects producing commodities for well-organised markets, the farm-gate price may not be too difficult to determine.

  In many cases, however, the prices in a reasonably competitive market or in the price records kept by the government statistical service will include services. The farm-gate price is generally also the best price at which to value home-consumed production. In some cases it may be extremely difficult to determine just what a realistic farm-gate price is for a crop produced primarily for home consumption because so little of the crop appears on markets.

  The farm-gate price may be a poor indicator of the true opportunity cost that we want to use in economic analysis. Again, this price distortion will have to be corrected in the economic analysis.

- **Pricing intermediate goods:** By emphasising the point of first sale as a starting point for valuing the output of our projects, we are also implying that imputed prices should be avoided for intermediate goods in our analysis. An intermediate good is an item produced primarily as an input in the production of another good. If an intermediate good is not freely traded in a competitive market, we cannot expect to obtain a price established by a range of competitive transactions. Fodder produced on a farm and then fed to the dairy animals in the farm is an example of such an intermediate product. If increased fodder production is an element in the proposed agricultural project, the analyst would avoid valuing it. Instead, the analyst would treat the whole farm as a unit and value the milk produced at its point of first sale or value the calves sold as feeder cattle. Treatment of intermediate products will vary from project to project depending on the particular market structures.

  To avoid most of the problems that might be introduced by trying to impute values for intermediate products, the financial accounts in agricultural projects are based on budgets for the whole farm instead of, on budgets for individual activities on the farm; that is to base on the budget for the egg farm, as a whole rather than on the budget for a pullet production activity.

  A frequently encountered intermediate good in agricultural projects is irrigation water. The "product" of an irrigation system – water – is, of course, really intended to produce agricultural commodities. The price farmers are charged for the water is generally determined administratively, not by any play of competitive market forces. If the analyst were to try to separate the irrigation system from the production it makes possible, (s)he would be faced with a nearly impossible task of determining the value of irrigation water. Hence, it is not surprising that the economic analyses of most irrigation projects take as the basis for the benefit stream the value of the agricultural products that are offered in a relatively free market at the point of first sale.

- **Project boundary price:** Prices used in analysing agricultural projects are not necessarily farm-gate prices. The concept of a farm-gate price may be expanded to a "project boundary" price if a project has a marketing component or if it is a purely marketing project.

Predicting future prices

Since project analysis is about judging future returns from future investment, as analysts we are immediately involved in judging just what future prices may be. This is a matter of judgement, not mechanics.

The best initial guess about future prices is that they will retain the present relationships, or perhaps the average relationship they have borne to each other over the past few years. We must consider, however, whether these average relationships will change in the future and how we will deal with a general increase in the level of prices owing to inflation.

- **Changes in relative prices:** We may first raise the question of whether relative prices will change. "Will some inputs become more expensive over time in relation to other commodities? Will some prices fall relatively as supplies become more plentiful?
- **Inflation:** In the past few years, virtually every country has experienced inflation and the only realistic assessment is that this will continue. No project analyst can escape deciding how to deal with inflation in his analysis.

The approach most often taken is to work the project analysis in constant prices. That is, the analyst assumes that the current price level (or some future price level – say, for the first year of project implementation) will continue to apply. It is assumed that inflation will affect most prices to the same extent so that prices retain their same general relations. Although the absolute (or money) values of the costs and benefits in both the financial and the economic analyses will be incorrect, the general relations will remain valid and so as the measures of project worth discussed. Working in constant prices is simpler and involves less calculation than working in current prices; for the latter, every entry has to be adjusted for anticipated changes in the general price level.

Pricing for internationally traded commodities

For commodities that enter significantly in international trade, whether inputs or outputs, project analysts usually obtain price information from various groups of specialists who follow price trends and make projections about relative prices in the future.

(i) Financial Export and Import Parity Prices: In projects that produce a commodity significant in international trade, the price estimates are often based on projections of prices at some distant foreign point. The analyst must then calculate the appropriate price to use in the project accounts, either at the farm-gate or at the project boundary.

If the farm-gate or project boundary prices for the internationally traded commodities in the project are already known and the prices in the particular country tend to follow world market prices, the farm-gate prices may be adjusted by the same relative amount as indicated, say, by the medium trend projected in the future relative prices supplied by one or another international organisation. Also, in financial analysis, if the farm-gate price is set administratively and is not allowed to adjust freely to work prices, the relevant price to use is the administratively set price.

Simply adjusting domestic prices by the same relative amount as foreign prices often arrives at figures too rough for project analysis. The approach ignores the fact that marketing margins in commodity trade tend to be less flexible than the commodity prices themselves. There are also many instances in estimating the economic value of a traded commodity that involves deriving a shadow price based on international prices. In such instances it is necessary to calculate export or import parity prices. These are the estimated prices at the farm gate or project boundary, which are derived by adjusting the cif (cost, insurance and freight) of fob prices by all the relevant charges between the farm gate and the project boundary and the point where the cif or fob price is quoted. The elements commonly included in cif and fob is given in Box 4.2.

Box 4.2: Elements of cif (cost, insurance, freight) and fob (free on board)

Item	Element
cif	**Includes**: • Fob cost at point of export • Freight charges to point of import • Insurance charges • Unloading from ship to pier at port **(Import)** **Excludes**: • Import duties and subsidies • Port charges at port of entry for taxes, handling, • storage, agents' fees and the like
fob	**Includes**: • All costs to get goods on board – but still in harbour of exporting country: - Local marketing and transport costs - Local port charges including taxes, storage, **(Export)** - loading, fumigation, agents' fees and the like - Export taxes and subsidies - Project boundary price - Farm-gate price

Source: William A Ward. (1977) *Calculating Import and Export Parity Prices.* Training material of the Economic Development Institute, CN-3. Washington, DC: Work Bank.

Economic analysis – the use of shadow prices

In economic analysis the economic and wider social impacts of a project is determined. In practice, shadow prices should be used in cost-benefit analysis only when the market prices of products and services clearly is distorted, i.e. do not reflect their scarcity value or economic contributions. In cases where market prices give a reasonable accurate indication of the scarcity of products and services, market prices are used not only in the financial analysis but also in the economic analysis.

In circumstances where the economic efficiency of projects is not reflected by market prices, project input and output prices should be adjusted. Examples of this are (a) where the market mechanism does not equate the marginal cost and marginal revenue of products and services or (b) where serious structural imbalances exist in markets inter alia due to government interventions due to "border" protection and direct subsidies; and (c) where markets are not sufficiently free and efficient to allow all secondary effects to be reflected in market prices.

The decision to use shadow prices will be influenced by the likelihood and consequences of the wrong use of market prices to reflect real economic values. A reasonable knowledge of the economy is therefore a prerequisite for responsible price choices in cost-benefit analysis.

The calculation of the shadow prices of products and services is often difficult and is further complicated because it may be necessary to calculate shadow prices on a regional basis, since structural imbalances may exist between regions which are not reflected in market prices.

- **Regional considerations:** Cost-benefit analysis is usually used to evaluate the effectiveness of projects undertaken within a specific national economy. Furthermore, the distribution of income between different population groups, income groups and regions is addressed in this way. Regional differences in costs and benefits are indeed very important when the effectiveness of projects is investigated and the distributional consequences are assessed.

  From this it follows that when market prices are used to value resources they should reflect the value for different regions. In cases where market prices are not acceptable, shadow prices should reflect the value of resources for the region where they are purchased. The same applies to surrogate prices.

  In order to include the above correctly in project evaluation, it is necessary to investigate the political influences affecting shadow and surrogate prices.

- **Political influences on shadow prices:** Political ideologies and choices underlie the nature of community benefits and the way in which they are maximised, and influence, amongst other things, the following:

  (i) The social time preference rate;
  (ii) the value of capital;
  (iii) market prices;
  (iv) job opportunities and wages, and consequently the value of recreational time;
  (v) the value of externalities, eg noise and damage to the ecology; and,
  (vi) the preferred income distribution and distributional weightings.

Political consideration therefore constitutes an integral part of decision-making. The analyst is forced to take them specifically into account when assessing any project.

- **Conditions for the use of shadow prices:** It is important to distinguish between the generally valid conditions for the use of shadow prices and the conditions specific to the use of shadow prices in a country.

  Any optimisation process presupposes limited resources. The economic problem is to find that combination of resources that maximises some goal function or other. Scarce resources are traded at certain prices. If certain conditions are met, the price mechanism is the best way in which scarce resources can be allocated to those who will use it to the maximum social advantage. The conditions are that:

  (i) the prices of final consumption goods should reflect their social consumption value; and
  (ii) the prices of scarce resources should give an indication of relative scarcity.

Provided both conditions are met, supply and demand on the goods and factor markets will tend towards equilibrium. As has been argued, price distortions that occur in practice will result in market prices not being true measures of scarcity, and this leads to the use of shadow prices.

Principles in the calculation of shadow prices

There are a number of important approaches relating to the way in which shadow prices ought to be calculated. The first can broadly be called the world price approach (Little and Mirrlees, 1980) and the second the opportunity cost approach (World Bank, 1979). A third important approach rests on the willingness of society or groups in society to pay for goods or services. The first two approaches form the basis of shadow price calculation while the willingness-to-pay approach is recommended only as method of calculating surrogate prices under certain circumstances, eg in the valuation of externalities or where policy restrictions prevents international tradability of goods and services.

- **World price approach:** This approach takes into account world prices of products and services, especially with regard to those goods that are freely traded on international markets, ie. tradable goods (see 4.4.2). Important examples are mineral and agricultural products for which active free international markets exist. Where local market prices, however, are distorted, the world price serves as shadow price after adjustments have been made for costs in the import and export of goods. This approach is not always reliable, because governments often peg currencies at artificial levels that do not reflect their scarcity value. Adjustments are then required in the value of the currencies. Not all inputs and outputs can necessarily be converted to currency value. For example, labour is one of the most important inputs in less developed countries, but there is no free international market making it possible to attach a world price value to surplus labour.

- **Opportunity cost approach**: The opportunity cost approach to determine the shadow price is reflected in the production that is given up by withdrawing resources from alternative use. For the shadow price of outputs the additional incremental benefit achieved by undertaking an alternative project relative to the situation had the project not been undertaken is used. The shadow price for resources such as labour and land is normally calculated by using opportunity costs, i.e. the value given up by not using these resources to produce alternative outputs. In the case of locally produced goods, which cannot be profitably trade in the world market, the opportunity cost (as reflected by the "willingness-to-pay" value) will be used.

- **Combining approaches:** Since international trade considerations, eg exchange saving, are also important in project assessment, internal prices will not reflect all the broader economic advantages and disadvantages. Therefore it was decided to combine the two approaches: the world price approach and the opportunity cost approach, in order to calculate shadow prices for project assessment more accurately. The approach is that where projects substitute imports or promote exports the world price approach is adopted. Locally purchased inputs are valued at international prices where the possibility exists that they could be imported or exported. The inputs for which no international prices exist (i.e. resources such as land, water and labour) are valued at local opportunity costs. This approach largely eliminates the individual disadvantages of each of the world price and opportunity cost approaches.

General problems with the determination of shadow prices

Shadow prices should be determined as scientifically as possible so that different project evaluators can achieve the same results. Therefore, it is important to take a stand on how externalities, inflation, taxation and subsidies, the project life and the value of currency should be dealt with.

- **Externalities:** Externalities are the effect of a project on the environment, ecology or general standard of living of a community that are not reflected by the prices of inputs or outputs. Externalities are difficult to include in project assessment because they are not directly allocable to the project and furthermore are hard to quantify. The requirement that prices of products and services should reflect their relative scarcity value on the basis of all costs and benefits continues to apply, however, and therefore externalities should be considered in the analysis of a project. Thus, for example, the opportunity cost of polluted water can be approached by using the degree to which government is prepared to bear or tax the cost of eliminating water pollution as a measure of society's willingness to pay for clean water. Where it is suspected that a project will produce some from of externality or other this aspect should be carefully investigated.

- **Inflation:** The object of a cost-benefit analysis is to measure advantages and disadvantages after the relative scarcity value of project inputs and outputs have been taken into account. However, inflation, the continued rise in general price levels, makes the determination of relative scarcity values more difficult. Inflation is not taken into account in the economic analysis and all evaluations are done in base year prices (i.e. real prices) with allowance for relative price shifts. (The financial results of profit-orientated projects viewed in nominal terms, on the other hand, are affected by the inflation rate, and the internal yield rate will have to be at least equal to, but preferably higher than the inflation rate to ensure that the project continues in existence. Alternatively the net present value of the project must be positive when costs and benefits are discounted with the aid of the inflation rate.)

- **Indirect taxes and subsidies:** Taxes and subsidies influence the optimal application of production factors and the analyst will have to take these into account indirectly when forecasting the combination of inputs that will apply after the implementation of the project. It is not, however, simple to deal with indirect taxes and subsidies in cost-benefit analysis.

  From the point of view of the economy as a whole, indirect taxes and subsidies are transfer payments, and when new inputs that have to be taxed or subsidised are looked at in the national interests, the value is calculated from the point of view of the producer by subtracting taxes and adding subsidies. When the effect of a project on a particular area is considered, however, the effect of indirect taxes and subsidies on the local economy has to be taken into account. In such a case the market prices, including the taxes and after subtracting the subsidy, indicate the social marginal value of the input or benefit. The tax saving or subsidy loss, should be shown as a redistribution effect from or to the overall authority respectively.

  It must be kept in mind that "taxes" charged on prices should be taken into account as part of the project cost. An example in the component of the oil price used to safeguard the oil supply.

  Sometimes confusion arises as a result of taxation which is levied for a specified purpose, which in reality serves as a consumer charge. The general point of departure here is that in circumstances where tax would normally be subtracted, all taxation, even taxes that serve as user charges, is subtracted from market prices to calculate the scarcity value, and that a cost-element is added for the use of the input. Where it is very difficult to impute the value, the analyst can consider keeping the tax in the price as an estimate of the user charge. So, for example, part of the tax on petrol serves as a user charge for the use of roads. The analyst can consider not subtracting this tax from the price of petrol so that it can serve as an estimate of the damage to existing roads that result from a project.

All direct taxation (e.g. income tax, value added tax) and indirect taxation is included in the financial analysis, but direct taxation is not taken into account in the economic analysis and indirect tax is dealt with as set out above.

- **Project life:** The project life is equal to the expected economic life of the project, which means that the analysis period will vary from project to project. Any assets which may remain at the end of the economic life of the project should appear as a residual item either as a benefit or a cost, depending on whether they are removal costs or externalities. The maximum long-term project life for CBA purposes is considered to be 25-30 years. Discounting of values in subsequent years add or subtract almost zero from the net present project values.

- **Currency:** The price of any imported product is converted by means of an exchange rate to internal price levels. It has already been argued that in the absence of free currency markets the exchange rate does not necessarily reflect the value of a currency and that it will therefore be necessary to determine a shadow exchange rate using another method.

  Because of the volatility of the exchange rate it is essential that exchange rate calculations go together with sensitivity analysis.

Determining the Values of Inputs and Outputs

The resources (or production means) are the scarce factors that are needed in the production process and that lead to the supply of goods and services by the private sector and government. The discussion that follows concentrates on general characteristics of means of production and the determination of the market prices and the shadow prices. These prices will be used to determine project benefits and costs.

Classification of inputs

During the production process project inputs are converted to outputs. The most important project inputs are capital, raw materials, labour and purchased inputs and services. Price information is usually available in market prices, but, as has been mentioned, the use of shadow prices is sometimes desirable.

- **Capital goods:** Capital goods are those production inputs that are not used up in a single period in the production process. For the purpose of this sourcebook they are divided into land, buildings and machinery, equipment and transport equipment. Capital goods are usually viewed as the fixed assets used in the project. As such, capital goods, like any other product, are subject to imperfect market conditions which result in the market price not reflecting the relative scarcity of the product. Therefore it is necessary to investigate the valuation of these production means for such incorrectly determined prices.

  Normally capital expenditure takes place at the beginning of a project. It may also, however, occur during the economic life of the project and in addition it may be necessary to replace capital goods during the life of the project.

- **Land:** Land can be used in the economic process in a variety of ways, e.g. as agricultural land, an industrial input or the basis of infrastructure creation. The market price of a given piece of land cannot simply be accepted as a measure of its scarcity. The inherent value of land is dependent on its physical characteristics, the climate, and the production technology used on it. The shadow price of land is based on its opportunity cost, in other words the optimal alternative use to which it can be put. In order to calculate this price, the following information must be available:

  (i) The historical use of the land and the value of the output derived from it in the past;
  (ii) Other developments in the area which can affect it; and
  (iii) Information concerning the proposed use of the land and the output from the new alternative application.

It is important to remember that the expected return of any project is determined by prices reflecting interventions and imperfections in the economy over the duration of the project. Therefore the expected return should be adjusted so that the economic value of the land can be calculated in terms of the economic value of the production in the optimal application.

An example can illustrate these ideas. The Department of Transport has to decide whether a local airport should be retained and upgraded or a new airport developed. An opportunity cost of zero (besides maintenance costs) is allocated to the existing runways on the grounds that there are no other uses for the runways and that their scrap value is zero. The land surrounding the airport does, however, have alternative uses in the form of low quality agricultural land or housing plots, which must be taken into account as such. In the case of an agricultural project the “without project” use of the land should be used as the opportunity cost of land.

- **Buildings:** Buildings are essential to protect the production process from the ravages of nature and as such are included in any cost-benefit analysis. In order to determine prices correctly, the following information may be useful:

  (i) The date on which the building was bought or built;
  (ii) The current building cost of an equivalent building and the book value of the building; and
  (iii) Alternative applications of the building.

  The shadow price of existing buildings is calculated on the opportunity-cost basis and that of new buildings on the basis of building costs. Where building costs serve as a basis for these calculations, adjustments have to be made for possible distorted labour prices which serve as an input, as well as for possible tariff protection on any locally purchased material inputs.

- **Machinery, equipment and transport equipment:** Machinery and equipment are not usually used up immediately in the production process. Except where it is destroyed by natural phenomena or man-made disasters, the equipment becomes obsolete as a result of wear and tear and the availability of better production technologies. Depreciation on machinery and equipment is never, however, reflected directly in any cost-benefit analysis. Depreciation is taken into account indirectly in that the cost of fixed assets normally appears at the point when it is made, usually at the beginning of the analysis period and the scrap or residual value appears as a credit at the end.

  The shadow price of machinery and equipment is determined in the same way as that of raw materials (by making a classification in terms of –

  (i) Machinery imported, with and without any restrictions on quantity and price; and
  (ii) Machinery purchased locally or made by the undertaker of the project.
  (iii) Where equipment is leased or where machinery is carried over from other projects to the proposed project, the use value is adjusted for labour content, tariff protection, other indirect taxes and subsidies.

- **Raw Materials:** Raw materials are found in a variety of forms and are converted through a variety of processes, by the addition of labour and capital, into goods and services. The opportunity cost (scarcity value) of a raw material, and consequently the shadow price of the raw material, depend on a number of factors.

  (i) Where a country is richly endowed with a raw material but the raw material is a diminishing asset, e.g. coal, it cannot simply be accepted that the market price reflects the relative scarcity of the asset, since the Government often influences the price for other reasons, e.g. in order to achieve a better balance of payments position.
  (ii) Monopolies or cartels are in a position to force the price of the raw material artificially to a level higher than its scarcity value.
  (iii) The subsidisation or taxing of the use of raw materials will distort the prices so that they no longer reflect scarcity values.
  (iv) Rationing restricts the demand for or supply of certain goods and distorts the market prices so that economic value is not reflected in the price.

  For a discussion of the shadow price of raw materials it is necessary to identify three possibilities.

  (i) Where raw materials are imported without tariff protection or purchased locally, the market price, which by definition is the world price plus freight and insurance (c.i.f.) to the point of consumption, is used in the economic analysis. In the case of quotas which increase the price of the imported products on the local market the same approach is used, in other words the shadow price is equated to the c.i.f. world price of the product. If government interferes with the operation of the currency market, however, adjustments should be made in the exchange rate.
  (ii) Where raw materials on which import tariffs are applicable are imported or purchased locally, the shadow price is calculated by subtracting the percentage tariff protection from the local price. In the case of quotas the c.i.f. world price approach is used.
  (iii) Where raw materials are purchased locally and these raw materials are not normally traded overseas without influencing the local price or the local availability of the raw material (e.g.

bricks) it can be accepted that the scarcity value or "willingness-to-pay" value of the product is reflected by its market price, adjusted for indirect taxes and subsidies.

- **Labour:** Labour differs in many respects from other production factors. In certain situations, for example, it is possible that there can simultaneously be a shortage of skilled labour and a surplus of semi-skilled and unskilled labour. At the same time factors exist in the labour market, which result in the labour wage not reflecting relative scarcity. One such factor is the fixing of minimum wages (through the pressure from trade unions or government policy), which forces the wage above the marginal product of labour and thus limits employment. All factors that cause the price of labour to deviate from the marginal product of labour should be considered in a cost-benefit analysis.

  The following approach to determine the shadow price of labour is proposed.

  (i) Where unemployment does not exist, the market price of labour is used for all labourers. If the quality of a specific category of labour within a sector is homogeneous and the market operates fairly freely, then the average wage of the category concerned in that sector can be accepted as reflecting the market price in the sector. Under conditions of full employment, and especially where skilled labour is particularly scarce, this estimate will probably underestimate the opportunity cost of labour, but in the absence of specific information it is not normally possible to calculate it more accurately.

  (ii) Where unemployment exists, the shadow wage of semi-skilled and skilled workers (excluding professionals and managers) is based on the average minimum wage for the lowest paid workers in the industry concerned. In general it is unlikely that a lower shadow wage will apply, so that the possibility of over-estimating the opportunity cost of the labour involved is small. Even under conditions of unemployment the labour of professionals and managers must still be valued at market prices, as normal market forces will largely influence wages for these categories.

  (iii) For a worker who has very poor technical skills and who lives in a region where unemployment exists, the average income per earner in the region is used as a measure of the production lost (shadow wage) when the worker is employed. Such income is usually lower than the minimum wage and is a more correct reflection of the opportunity cost of labour.

- **Services:** Purchased services are not always concrete or visible in the final product or service that is produced, but nevertheless form an integral part of the product or services, eg electricity, gas, water, transport, promotions, advertising and research and development. The opportunity cost of a service is the value that the rest of the economy has to forgo if they are denied the service or the cost imposed on them to deliver the service. If, for example, a project needs electricity, the shadow price of the electricity in a given region will be equal to the long-term marginal cost of provision. The same approach applies to the cost of water, gas and transport.

Box 4.3: Principles to be kept in mind in evaluating benefits and costs

- In valuing inputs the opportunity cost of the resource in its most rewarding alternative use should be used.

  Note: The input resource should not be undervalued for the purposes of the particular project;

- In valuing benefits, where the service provided by the project is not freely traded, more indirect methods of willingness to pay for the benefits need to be used.

  Note: A variety of techniques are available to measure these values.

Tradable and non-tradable goods

Cost-benefit analysis attempts to measure the efficiency with which scarce resources are applied in the realisation of a clearly defined set of objectives. Economic efficiency assumes that all goods and services as potentially tradable (directly and indirectly). All project inputs and outputs therefore have opportunity costs. Tradable goods can be defined by c.i.f. (importable products) and f.o.b. (exportable products) prices. Where a good is non-tradable the world market cannot be used to determine the opportunity cost. In such situations a good is viewed as non-tradable.

The terms tradable and non-tradable deal with the issue of tradability in principle – ie. taking into consideration that comparative advantage and transport costs only.

A non-tradable good is defined as when:

c.i.f. ≥ Local Cost of Production > f.o.b.

A non-tradable good can thus not be sold at a profit in the international market because the f.o.b. price is lower than domestic production cost. It is on the other hand not viable to import goods because the local cost of production is lower. Such a good can therefore only be traded in the domestic market while these particular conditions prevail. The "willingness-to-pay" will apply to value non-tradable goods.

A tradable good would be subject to one of the following conditions:

Importable good: c.i.f. ≤ local production cost
Exportable good: f.o.b. ≥ local production cost

The value of tradable goods will be determined by the "world price" (cif or fob).

Due to inflexibilities the following goods are defined as non-tradable: Labour and Land. Opportunity costs will be used to determine shadow prices (see section 4.3.6) of non-tradeables.

- **Traded and non-traded goods**: The terms traded and non-traded goods are more practical as they take into consideration not only comparative advantage and transport costs, but also (expected) government policies on trade. Thus, a good which is tradable in principle may be non-traded in practice because there is expected to be an import ban on the good during the life of the project. A shadow price value assuming tradability may therefore be unrealistic.
- **First and second best shadow prices:** A first best situation would be if all tradable goods would be traded. In such situations "first-best" shadow prices are used to calculate the economic values of project goods. However, if tradable goods are rendered non-traded due to policies or government interventions a more realistic value would be find in a "second-best" shadow price. In this system all non-traded goods are valued as non-tradables. "Willingness-to-pay" criteria will then be applied to determine the shadow value of non-tradables.

Steps in the determining of shadow prices

Step 1: Identify tangible/intangible goods

A first step in determining shadow prices is to decide whether a good is tangible or intangible. If a good is intangible it remains important to describe it in a quantifiable manner. Such goods should, however, not be valued. If a good is classified as tangible it should be determined as either a direct transfer payment, or because real resources are used in its production, as traded or non-traded.

Step 2: Eliminate all direct transfer payments

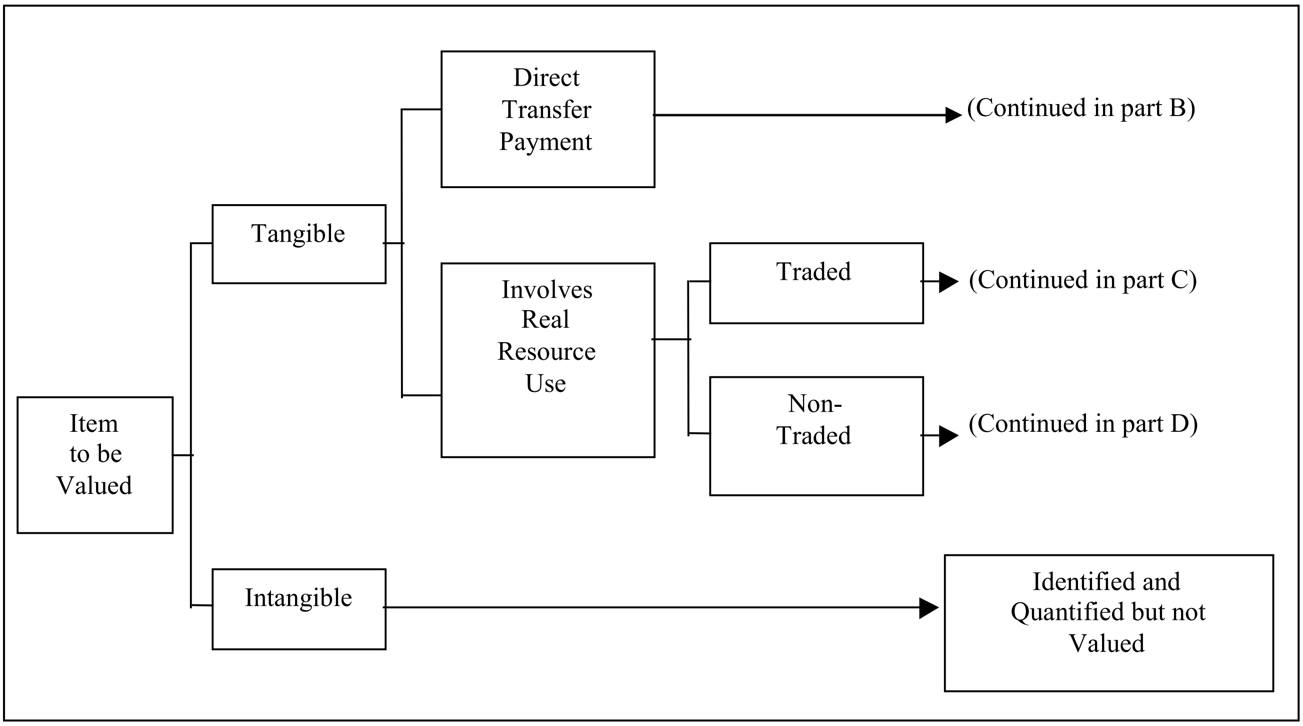
Step 3: Value traded items

Step 4: Value non-traded items

The decision trees for determining economic values for various components are summarised in Figure 4.1 to Figure 4.4.

Figure 4.1: Decision Tree for Determining Economic Values: Major Steps

Figure 4.2: Decision Tree for Determining Economic Values: Direct Transfer Payments



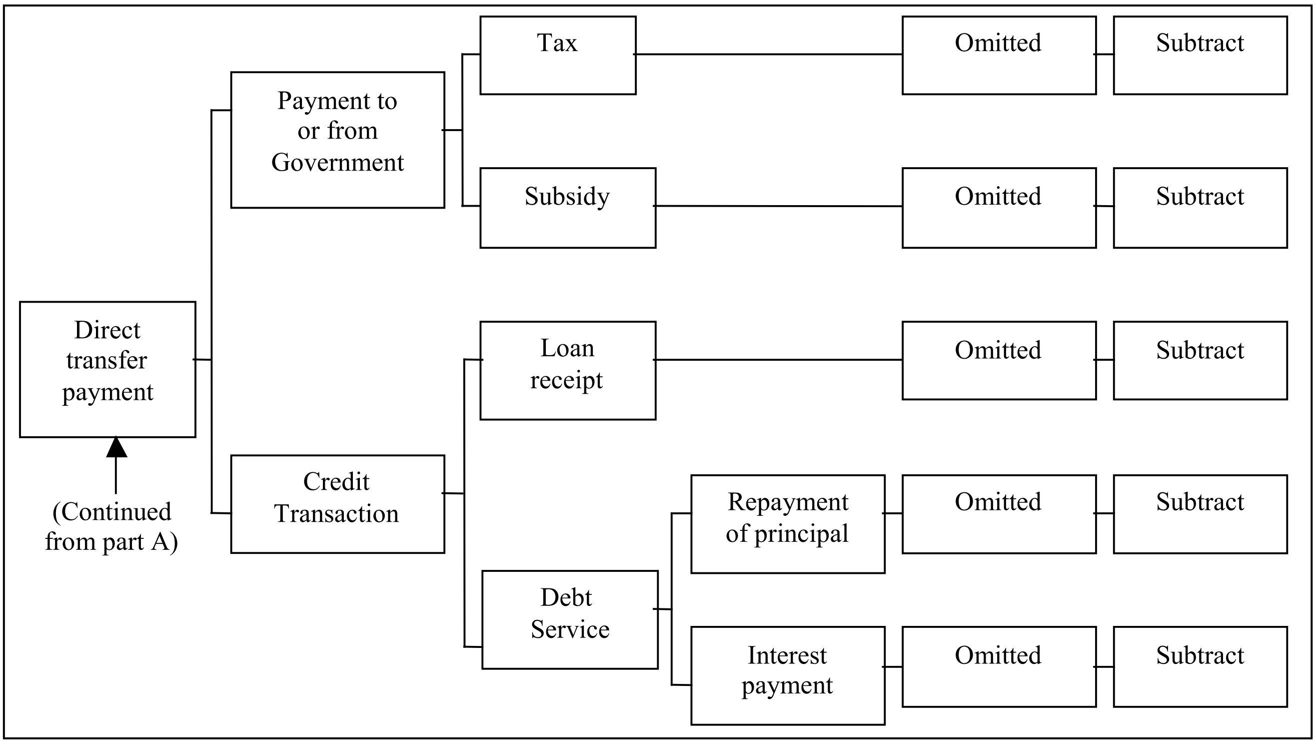


Figure 4.3: Decision Tree for Determining Economic Values: Traded Items

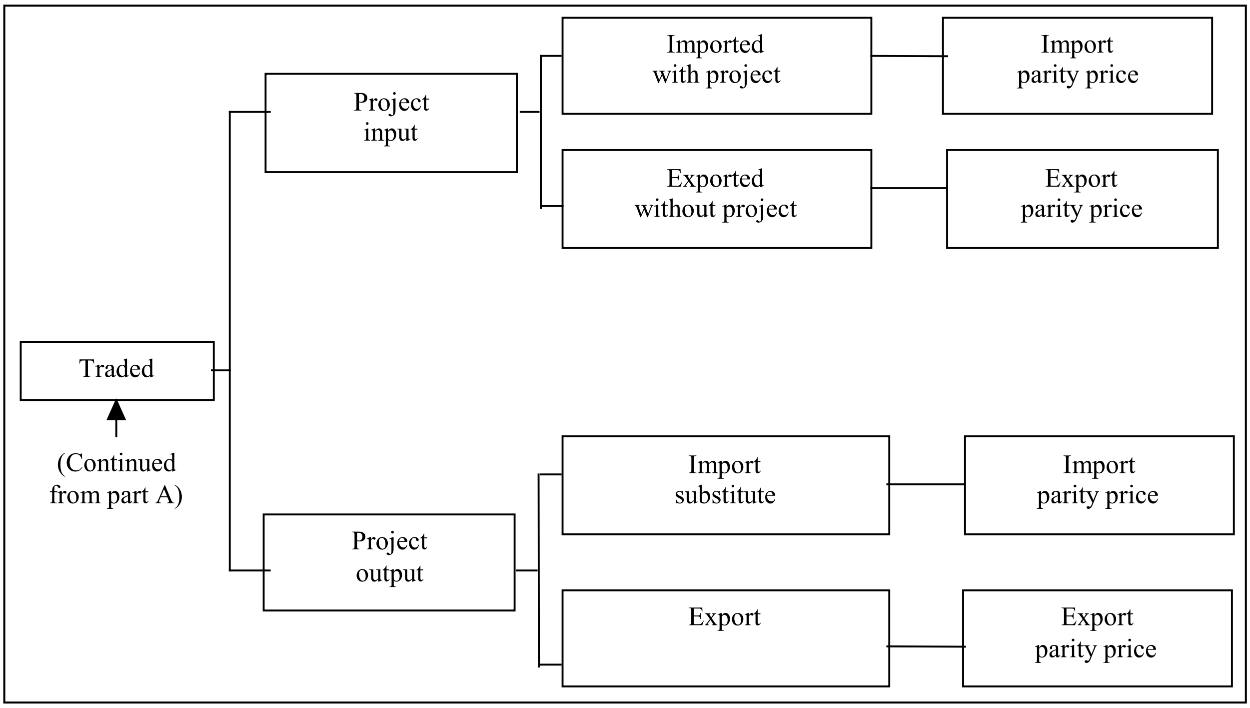
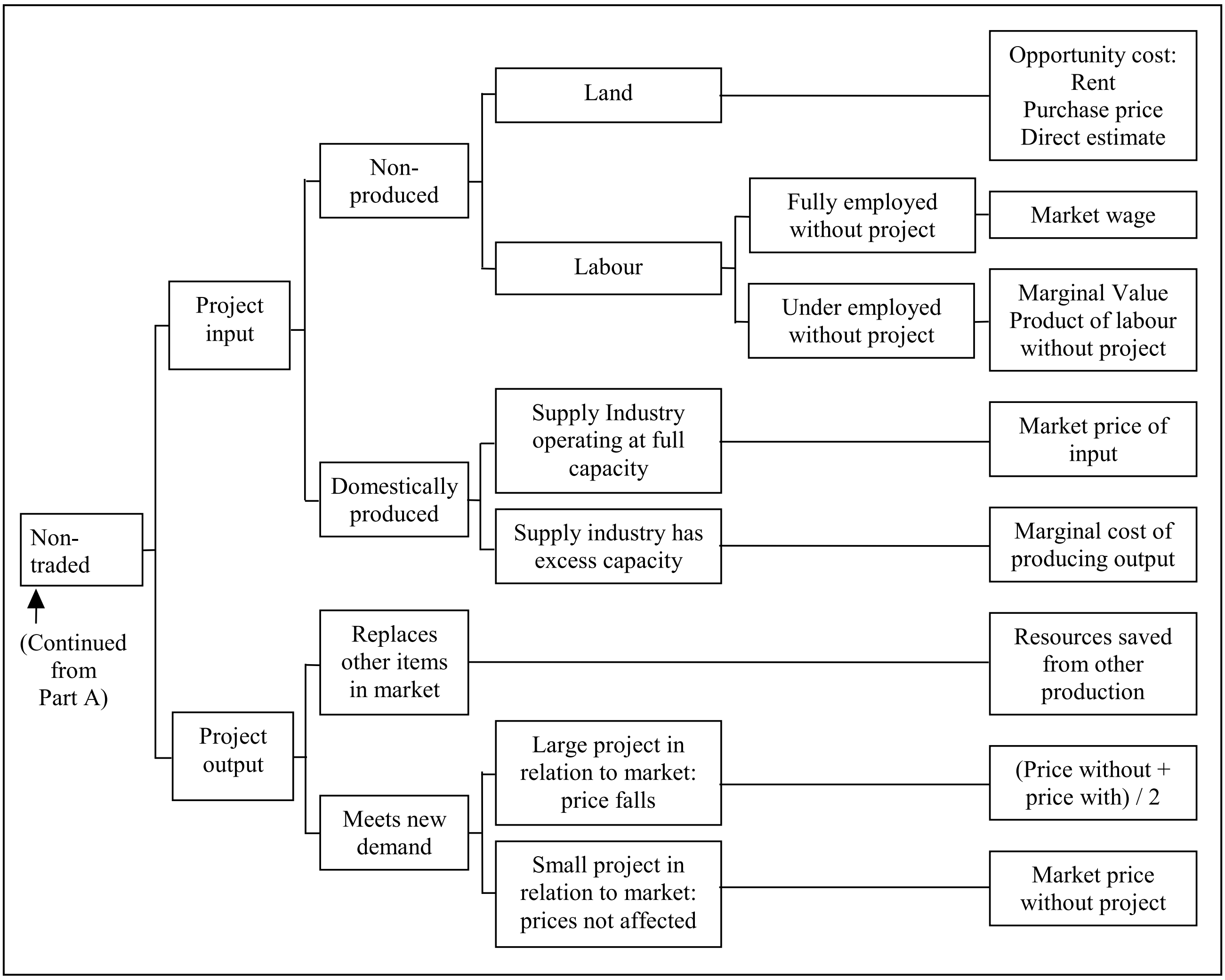


Figure 4.4: Decision Tree for Determining Economic Values: Non-Traded Items



Comparing benefits and costs (Project Decision-Making Criteria)

After completion of the financial and economic analysis, every project should be assessed individually in order to determine whether it would increase general welfare by using scarce resources as efficient as possible. Where the composition of a capital expenditure program is concerned, the project should be ranked in priority order in terms of financial and economic criteria. In this section the project decision criteria are discussed systematically and an indication is given of the most suitable criterion to use under certain conditions. This is followed by a discussion of sensitivity analysis and some further problems are touched on briefly.

Definition of terms

(i) **Mutually exclusive and independent projects:** By mutually exclusive projects is meant alternative methods of performing the same task or reaching the same goal. If the aim is to increase production through securing a more stable irrigation water supply, a variety of alternatives can be considered, ie. alternative water damming options, pumping directly out of a river, etc.. Eventually, only one of the alternatives will be chosen. The economic assessment of mutually exclusive alternatives therefore involves the choice of the most cost-effective alternative.

Independent projects are completely unrelated and more than one of the projects can be carried out. In fact, it is possible to carryout all independent projects where there is no shortage of funds. Examples of independent projects are the construction of a dam in a river and the construction of a bridge across another to link two towns between towns C and D. Where funds are scarce, however, it is important to rank the projects in order of acceptability so as to determine which projects should enjoy the highest priority. Even if it is possible to finance all projects, it is still important to have criteria that can be applied to ensure that each project is in the interest of the community.

Logically speaking, projects are assessed in a set order. The mutually exclusive projects are usually assessed first to find the most cost effective alternative, after which the chosen project competes for funds with other projects, which are chosen in the same way (all independent of each other), in a second assessment phase. The most effective alternative in a particular situation is not necessarily the best project when a program is being compiled.

(ii) **Time Value Of Money and Discounting**

Compounding: A dollar received and consumed today by an individual or society has a higher value than the same dollar received and consumed sometime in the future. This is “time value” of money and should not be confused with inflation. Interest rates reflect time values as defined by the financial markets. To determine future value of money, therefore, a compound interest rate is applied and this process is generally referred to as compounding. The future value is determined by multiplying the present value by the expression:

$$(1+i)^n$$

Where: i = interest rate and n = the number of years.

This compounding expression is also known as the compounding factor and is used to derive sets of compounding tables.

$$\frac{1}{(1+i)^n}$$

Discounting: Discounting is the opposite of compounding and the process involves finding the present value or worth of a future amount. The present worth of a future amount is determined by multiplying the future amount by the following expression, also known as the discount factor:

Where: i = rate of interest/discount and n = number of years into the future. The discount factor is used to derive sets of discounting tables.

Discounting is an essential step in financial and economic analysis because this translates all future costs and benefits to present values. The present value is a common measure that can be used to compare projects of different life spans. Discounting allows us to compare costs and benefits occurring in dissimilar time periods. Discounting and compounding and the decision rules are summarised in Box 4.4.

Box 4.4: Time Discounting and Decision Rules

- Project benefits and costs occur over time;
- If benefits accrue at a constant rate over 20 years, it is unsafe to assume that a benefit in year 2 is regarded by society in the same manner as a benefit in year 19;
- Treating $1 in year 2 as being the same as a $1 in year 10, implies that society is indifferent as to when it receives the $1;
- One can deposit the $1 in a savings account and earn interest, i.e. the $1 in year is valued more than the $1 in year 2 because there exists a positive interest rate in the economy;
- The principle is that individuals have a positive time preference, i.e., prefer now to later;

$1 in Year 1 Accumulates to $(1 + r) in year 2
Where: r is the interest rate
$1 in Year 2 is Worth $1 / (1+ r) in Year 1
Similarly, $1 in year 3 is expressed as a value in year 1 as:

$$\$1 / (1+ r)^3$$

Generally, a benefit B_t in any year t will have a value in year 1 of:

$$B_t / (1+r)^t$$

The value in a year 1 is the present value (PV) and the procedure for determining it is called discounting.
The expression:

$$1/ (1 + r)^t$$

is a discount factor.

- Future values (FV) are obtained by a reverse process called compounding.

$$FV = PV (1 + r)^t$$

The expression:

$$(1 + r)^t$$

is a compounding factor.

- There is an additional adjustment to be made with respect to benefit and costs to ensure that they are expressed in real terms, i.e., net of any general movements in price levels;
- The effect of changes in the purchasing power of the dollar is to be removed from the benefit and cost streams;
- The process of converting current dollar values into constant dollar values is known as deflating;
- Different deflators can be used. The most common deflators being the consumer/producer price index (CPI/PPI);
- CPI is expressed as a ratio of the CPI in the relevant year, e.g. 1996, to the CPI in the base year, e.g., 1980.
- Project cash flows need to be adjusted by a factor that accounts for the effects of both inflation and time preference;
- In benefit – cost analysis, the concern is the net benefit to the whole society, therefore, a social discount rate needs to be used;
- Social discount rates are lower than market rates because society's planning frame is longer than that of private individuals.

- **Time Preference Rate:** In projects, cash inflows and outflows are generated over a number of years, there is a need to measure benefits and cost in common units. The common unit, as shown in the previous section, is generally a monetary value in a particular year. In estimating the present value, two aspects need to be considered: the effects of inflation, and the characteristics of time preference.

- **Inflation**: The purchasing power of the currency over the years varies. To make the discounted values directly comparable, they must be adjusted by a factor that accounts for the change in value of money over time. Usually the factor used is the consumer price index (CPI) expressed as a ratio of the CPI in the relevant year (e.g., 1975) to the CPI in the base year (e.g., 1995). In this way, the cash flows can be expressed in common dollar values.

If project cash flows are expressed in actual (or nominal or current) dollar values, they need to be adjusted by a factor that includes the effects of both inflation and time preference. If the cash flows are expressed in constant (or real or inflation - adjusted) terms, they need to be adjusted only by a time preference factor. If the evaluation is of a cash flow that extends both before and after the base year, then the earlier values need to be compounded forward, and the later values discounted back to determine the base year values.

An important issue in undertaking cost-benefit analyses of publicly funded projects is choosing the appropriate discount rate. The conduct of publicly funded projects is aimed at generating benefits for the general public of groups in society using public funds. Thus the project results are characterised as social benefits and the project evaluation is a social cost benefit analysis.

Approaches to the choice of discount rates are:

- Social time preference approach (STP) - which allows the comparison of different (real) cash flows at different points in time. This approach is based on the premise that individuals prefer consumption now rather than in the future; and
- Social opportunity cost approach (SOC) - a method of achieving a proper balance between investment in the private and public sectors. If the total investment funds are limited, investment in the public sector competes with investment in the private sector. For the economy to gain the highest potential return, the same discount rate should be used in the private and public sector. Therefore, public sector investments are valued at the opportunity cost of those funds.

In a perfect world, the STP rate equals the market rate of interest on risk free, long-term bonds (around 3 percent). The SOC rate in theory should be the rate used in practice to appraise risk-free private sector investment (U.K. about 5 percent). The SOC rate is higher than that usually taken to reflect STP. Proposed public sector projects should be considered if they generate returns greater than these test discount rates.

In economic analysis, the discount rate used is normally lower than the market rate. This lower rate is also referred to as the “social time preference rate.” It is generally agreed that society as a whole plans over longer time horizons than private individuals and firms. Society is, therefore, more inclined to place greater value to future consumption or deferring to future generations than private firms. In practice, however, this rate can only be estimated. As a rule of thumb, this is lower than market rates of interests and may be reflected in long-term government bonds.

Project assessment criteria

There are several decision criteria with which project benefits and costs can be compared. These can be classified broadly as restricted methods or more comprehensive methods.

(i) **Restricted methods:** These criteria include the payback period method, the peak profit method and the average profit method. All three are very simple and are restrictive because economic efficiency is not the main consideration. As a result, these limited methods may produce misleading results. The use of these methods is not recommended, and therefore they are not discussed here in detail.

(ii) **Discounted Measures of Project Value:** A number of measures exist to measure the discounted project worth. The three commonly used measures are net present value (NPV), internal rate of return (IRR), and benefit-cost ratio.

- **Net Present Worth (NPW) - also known as Net Present Value (NPV):**

The NPW of a project is the sum total of discounted INB:

$$NPW = \sum_{i=0}^{n} \frac{B_i - C_i}{(1+r)^n} \; or \; \sum_{i=0}^{n} \frac{INB_i}{(1+r)^n} \; or$$
$$= \sum_{i=0}^{n} \frac{B_i}{(1+r)^n} - \sum_{i=0}^{n} \frac{C_i}{(1+r)^n}$$

Where: r = discount rate, n = number of years, i = i^{th} year, B = benefits, C = costs, INB = incremental net benefit.

- **Internal Rate of Return (IRR):**

The IRR is the discount rate where the net present worth of costs is equal to net present worth of benefits, i.e., the NPV equals zero. IRR is *r* where:

$$IRR = \sum_{i=0}^{n} \frac{INB_i}{(1+r)^n} = 0$$

The IRR is calculated iteratively, manually, or by computer.

- **Benefit/Cost Ratio (B/C):**

The B/C is determined by dividing discounted benefits by discounted costs:

$$B/C \text{ Ratio} = \frac{\sum_{i=0}^{n} \frac{B_i}{(1+r)^n}}{\sum_{i-0}^{n} \frac{C_i}{(1+r)^n}}$$

Applications of measures

These measures are used singly or in combination. The NPW is an absolute measure, and is a more appropriate measure for similar projects and/or cost outlays. If funds are limiting, this measure is useful for comparing mutually exclusive projects. The IRR is a popular measure, and a project is considered viable where the IRR is greater than the interest rate in the financial analysis and greater than the social time preference rate in economic analysis. The B/C ratio, like the IRR, is a relative measure, the greater the ratio the more viable the project is.

The solution and ranking principles are summarised in Table 4.1.

Table 4.1: Selection and Ranking Principles for Investment Analysis

APPROACH	SELECTION PRINCIPLE	RANKING PRINCIPLE
Internal Rate of Return	Select the investment if and only if the internal rate of return exceeds the cost of raising investment funds.	Rank all investments in order of decreasing internal rate of return.
Net Present Value	Select the investment if and only if the net present value is present.	If investments are substantially the same size, rank in order of decreasing net present value.
Benefit – Cost Ratio	Select only if the ratio is greater than one.	Rank all investments in order of decreasing benefit – cost ratio.

Any lower cut-offs than those given here as selection principles would result in the research agency making a loss (though not always on the same basis). A more stringent selection principle, under any of the approaches, might be to take the highest ranked group of projects that exhausts a fixed research budget. In addition, projects having more than some specified risk of making a loss might be eliminated.

Sensitivity analysis

In any project evaluation there is a great deal of uncertainty. For example, the analyst may be uncertain of benefits, costs, shadow prices, the social discount rate or a combination of these variables. The problem is to test the project in order to show the effect of any assumptions and possible related uncertainties on the result of the assessment. This analysis is known as sensitivity analysis; its aim is to determine which of the assumptions concerning the project should be subject to further study. It is a simple technique in which different values are attached to uncertain variables in order to demonstrate to the decision-maker what the effect of variations in the assumptions will be. It is an attempt to show how sensitive the decision is to certain assumptions. With the aid of a sensitivity analysis the marginality of a project can be determined, ie. how sensitive the funding criteria are in respect of the assumptions and how sensitive the ranking of projects is in respect of the assumptions?

Sensitivity analysis must not, however, be misused in presentation. It must not serve as an excuse for not quantifying and must not be presented as a complicated set of conversion rules which cannot identify a clear first choice for the decision-maker. If carried out properly, sensitivity analysis will lead to more optimal decisions and it should go without saying that such an analysis will accompany the results of a cost-benefit analysis.

Sensitivity analysis is an analytical technique to test systematically what happens to earning capacity of a project if events differ from estimates used in planning. This is a means of dealing with uncertainty about future events and values.

Switching values

Switching values is a variation of sensitivity analysis. Here, we calculate how much an element would have to change in an unfavourable direction before the project would no longer meet the minimum level of acceptability as indicated by on of the measures of project worth. The appraisal determines how likely it is that there will be a change of that magnitude.

Decision Criteria Under Risk

Probability distributions of outcomes assist decision makers to decide on the viability of projects by balancing the magnitude of value with the estimated risk associated. Risk-takers will tend to accept those projects with higher possible returns, even in the face of higher risk. Those risk-averse will tend to accept those projects where certain minimum returns are feasible at lower risk, even if this may not lead to maximum profits.

Externalities

Any externality is defined as an effect of a project felt outside the project, and not included in the valuation of a project. Externalities exist when production or consumption of a good or service by one economic unit has direct effect on the welfare of producers or consumers in another unit.

(i) **Technological Externalities:** Technical externalities affect the technical relations and productivity of those outside the project, such as:

- Pollution;
- Silting downstream because of resettlements; and
- Training workers who leave for another employer.

(ii) **Pecuniary Externalities: Pecuniary externalities arise when the project affects the prices paid or received by alternate outside projects, such as:**

- Backward linkages – affects supply; and
- Forward linkages – affects demand.

(iii) **Social and Environmental Externalities and Rates of Return to Research: An externality value should be added or subtracted from the economic surplus (or gross benefit for benefit - cost analysis). By definition, externalities are not included in developing supply and demand curves.**

Net Social Benefit = Economic Surplus – Adoption Cost – Research Cost ± Externalities.

Examples of externalities that can at least be partially valued are:

- Soil Erosion:
  Replacement cost of soil nutrient loss; and
  Off-site effects such as siltation of reservoirs.
- Ground water recharge from rock bunds:
  Cost avoided of new well construction.

Benefit-Cost Approach and Research Investment

In most developing countries, agricultural and natural resources research is invariably supported from public sector investment. Therefore, most ROR estimates are essentially estimates of the benefits and costs to the society, i.e., economic analysis. In estimating the benefit and cost streams of research investments, depending on the time when the analysis is conducted, one needs to make some decisions with respect to the estimates to be used in the analysis. The three major items that require some discussion are probability of success, the diffusion rate of technology, and the benefit flow period.

Adoption rate/diffusion rate

The adoption rate of any technology depends on several factors. The key determining factors are:

- Magnitude of cost saving;
- Complexity of the technology
- Probability of obsolescence; and
- Adoption costs to the farmer.

Normally the adoption rate for *ex-post* studies is estimated based on:

- Actual field observations (area sown, etc.); and
- By projecting past adoption of similar technologies.

In the case of *ex-ante* analysis, the expected level of adoption depends on a number of factors. Again, subjectively estimated, these factors are:

- Information on the strength of extension services;
- Type of farming community; and
- Previous high-level of adoption of new technology, or similar technologies are used.

For *ex-post* studies, it is often agreed that three years after completion of a project may give the best reasonable indication of the source of economic benefits and their magnitudes. Thus, the earliest time an adoption study should be carried out is three years after the release of the recommendation, or three crop cycles in the case of crops. However, assumptions regarding the distribution of benefits, and the flow of benefits, should be made beyond the three-year period.

Probability of success of a research effort

The probability of success of a research effort is only relevant for ex-ante analysis. The probability of success of any research project depends on:

- The assessment of experienced and knowledgeable scientists;
- The characteristics of the enterprise, and the regions where it is produced;
- The type of research that is envisaged;
- The number and ability of research scientists to undertake the research;
- The structure of the research system, and the facilities; and
- The previous research which has been conducted both nationally and internationally on the issue.

These factors are considered, and subjective (probabilities) estimates are made.

Benefit flow period – life of project

In assessing agricultural technologies, it is often assumed that the effect of any technology in general is incremental. Even if a new technology replaces the old technology, the benefits of the technology are restricted to the increment it provides over the old, and they are evaluated accordingly. Therefore, it has been argued that it is appropriate to count down the benefit of the old technology indefinitely into the future. The only exception is when the old technology loses its effectiveness, and productivity reverses to the level pertaining prior to its release, e.g., if a disease resistant variety loses its resistance. The discount rate sets the upper limit for the benefit flow period. The present value of a dollar of benefits 40 years in the future is worth 2.0 cents in current dollars at 10 percent discount rate.

The length of the lag between agricultural research expenditure and effects on agricultural output are quite long. Chavas and Cox (1991) estimated that public sector agricultural research benefits occur anywhere from 8 to 30 years after the expenditure, with maximum effects at 23 years. In the private sector agricultural research, benefits occur anywhere from zero to 23 years later, with maximum effects at 15 years. Using a different methodology, Pardey and Craig (1989) concluded that lags of up to 30 years may be necessary to capture all the benefits from agricultural sector research, compared with only 10 years for the analysis of the private sector non-agricultural research.

Note on distortions

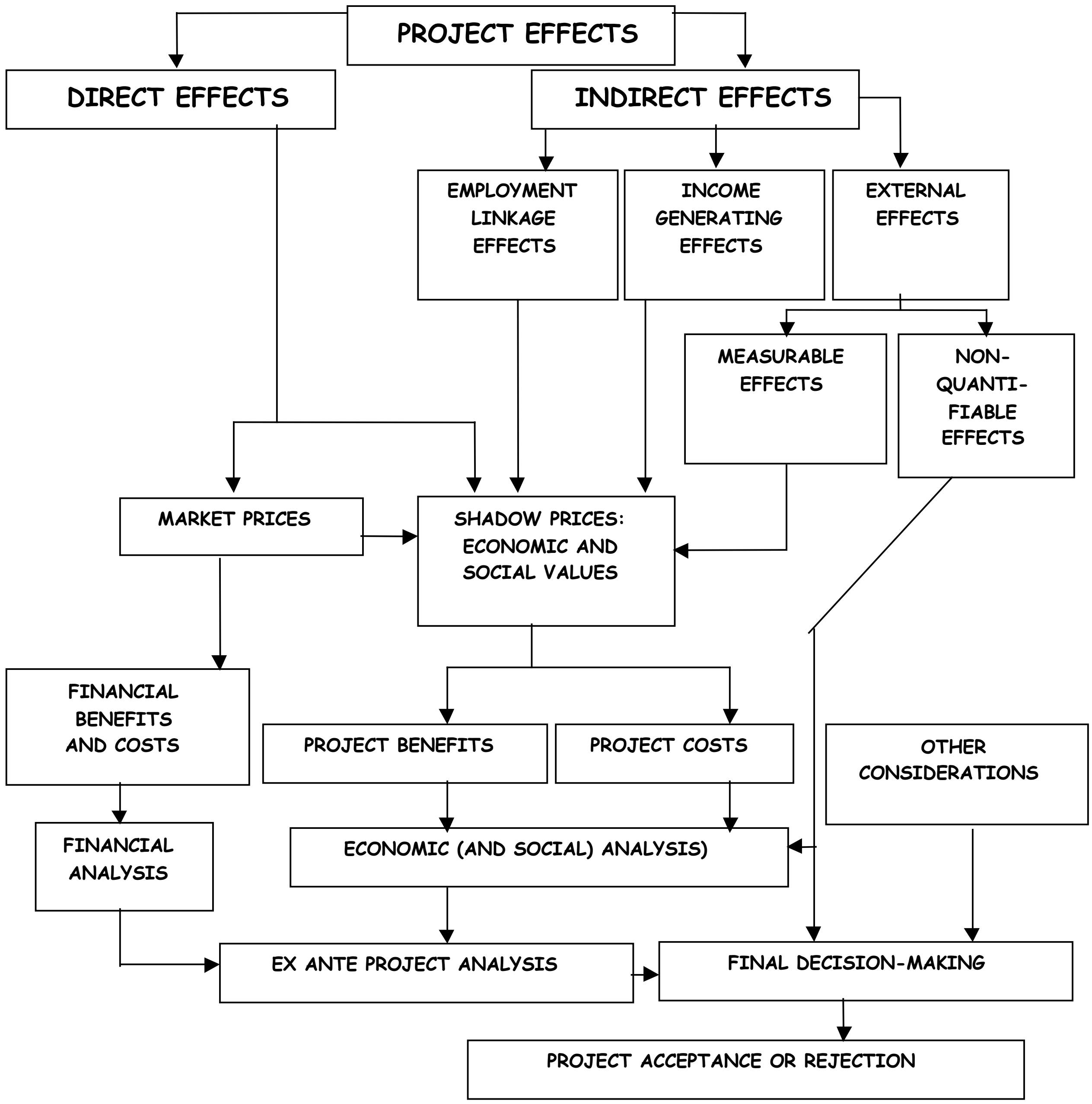
The current paradigm for R&D evaluation is based on investment project analysis. This framework is most useful for assessing projects that have a well-defined technology, a fixed time frame for implementation including adoption, a market for output, and a central capital component (Horton 1990).

The current ex-ante and ex-post assessment tools are far less useful in the case of research which is best treated as a long-term process, rather than a discrete project. Here the research process cannot be clearly specified in advance. The process evolves as discoveries are made. The time frame is unpredictable. The practical outputs are difficult to anticipate. Serendipity is an inherent characteristic of the research process. The most critical determinant of outcomes is not the financial investment, but the quality of work that is influenced by many environmental factors, economic and political environment. Hence, in research, the relationship between benefits and costs is much less predictable and measurable than it is in “standard” investment projects. Over emphasis on the investment project approach may induce research managers and researchers to divert resources to those activities that have obvious and easily identifiable and understood results. This may also reduce the incentives for basic research, since the output of the research process in this case tends to be some relatively abstract knowledge whose relevance and commercial applicability may not be readily apparent

Summary: A Schematic representation of the CBA Process

Firstly, CBA start with identification and description of effects which give rise to costs and benefits (direct, secondary and external). Secondly direct benefits and costs are quantified and valued – through market prices in the financial analysis and by applying shadow prices in the economic analysis. In the economic analysis the economic efficiency of resource allocation for the society at large is determined. All effects are accommodated ie. direct and secondary. The direct profitability for the various role players are calculated in the financial analysis process. Financial and economic costs and benefit values are compared as a third step to determine the net impact of a project. The judgmental assessments of all secondary and intangible effects are incorporated in the final discussion-making process where projects are rated and/or rejected or accepted for implementation. In this step both quantified results from the CBA and the quality assessment of non-quantified impacts is required to reach a final decision. Judgement therefore plays an important role in project appraisal and decision-making.

Figure 4.5: Schematic Framework for the Inclusion of Project Effects in Economic Project Analysis ("with" and "without" scenarios)



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THE MANAGement OF PROJECTS: FINANCES, MATERIALS AND HUMAN RESOURCES

Introduction

The management of projects focuses on the implementation phase of the project cycle. In this chapter only three, albeit important dimensions of this activity will be discussed, viz the management of money flows; procurement and the managing of materials; and human resource management.

Project Objectives

History of the project management

The history of large projects if often referred back as far as the construction of the Egyptian Pyramids and Great Wall of China. They were certainly large and complex structures, built to high standards, which must have liquidated vast amounts of resources. Unfortunately, there is no documented evidence of any project management systems and the management techniques used can thus only be based on conjecture. It can, however, be assumed that the objectives for such massive activity were an important guiding force for the successful completion thereof.

The objectives of any project can be grouped under three headings:

Performance and quality

The end result of the project must be fit for the purpose for which it was intended. The specification, the project owner and all the other stakeholders must be satisfied.

A copper refinery intended and designed to process 200 000 tons of cathode copper per annum must be able to do so, and it must produce that copper at the specified level of purity. The plant must function reliably, efficiently and safely. In these enlightened times there will be serious trouble for all concerned if operation of the plant causes environmental pollution.

Development projects for consumer goods must produce articles that satisfy the market requirements and conform to all relevant legislation. The design concept and manufacture have to result in a product that is safe, reliable and appealing to the consumer.

At one time quality was seen primarily as the responsibility of the quality control department, relying on inspection and testing to discover faults and then arranging for their rectification. In more recent years, the concept of total quality management has gained credence, with responsibility for quality shared by all the staff and workforce from top management downwards.

Most of the work on project management focus on achieving time and cost objectives. Achieving quality, performance and reliability objectives obviously requires competence in engineering and design. This however, must be complemented by adequate quality management (for which the ISO 9000 series of standards is widely accepted as the base from which to design, implement and operate an effective quality management system).

Budget

The project must be completed without exceeding the authorised expenditure. For commercial and industrial projects, failure to complete work within the authorised budget will reduce profits and the excepted return on the capital invested, with risk of a loss or a more serious (and terminal) financial outcome.

There are many projects, however, where there is no direct profit motive; Examples include internal management projects, pure scientific research programmes, charitable works and projects carried out by local authorities using public funds. For these projects too, even in the absence of a profit motive, careful attention to cost budgets and financial management is vital.

Financial resources are not always inexhaustible and a project might have to be abandoned altogether if funds run out before completion, in which case the money and effort already invested become forfeit and must be written off. In extreme cases, the project contractor could face ruin.

Time to completion

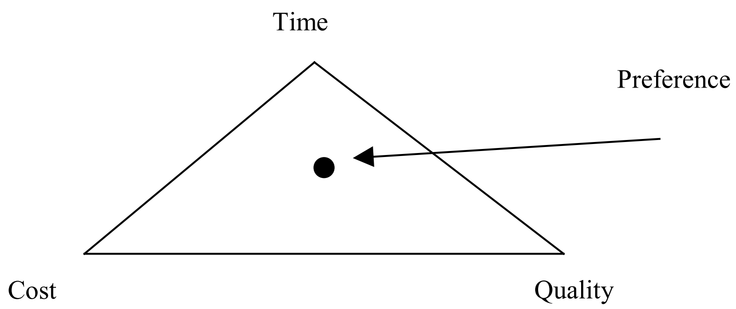
Actual progress has to match or beat planned progress. All significant stages of the project must take place no later than their specified dates, to result in total completion on or before the planned finish date. Late completion or delivery of a commercial project, to say the least, will not please the project purchaser or sponsor. Consistently failing to keep delivery promises cannot enhance the contractor's market reputation. Further, any project that continues to use the contracting company's resources beyond its scheduled finish date is liable to have a knock-down effect and disrupt the company's following projects.

A common risk to projects is failure to start work on time. Very long delays can be caused by procrastination, legal or planning difficulties, shortage of information, lack of funds or other resources, and a host of other reasons. All of these factors can place a project manager in a difficult or impossible position. If a project is not allowed to start on time it can hardly be expected to finish on time.

The overall objective is to complete the project within the time, cost and quality constraints set by the client. To achieve this, the project manager must subdivide the client's scope of work into a list of project activities with associated objectives.

The objectives associated with these activities can now be clearly identified and communicated to the responsible parties. The use of graphics (bar charts, networks) will greatly assist the dissemination process.

The triangle of forces is often used to graphically outline the trade-off between the main parameters of time, cost and quality.



This simple model does not consider any external influences which could impose further constraints on the project.

Management by objectives (MBO)

The Management by objectives (MBO) technique assigns responsibility of the completion of achievable objectives. These objectives will be defined by the project manager as apart of the planning and control system. The monitoring of these objectives can be effectively controlled using management by results.

Management by exception (MBE)

To supplement the Management by Objectives approach, there is another management technique, called Management by Exception (MBE). The MBE technique focuses the manager's attention on the activities that have gone off course and need to be controlled to ensure the activities will meet their objectives.

The MBE technique uses a filter to select the non-conforming activities. When projects have a 100 or more activities the project manager cannot effectively monitor all of them.

MBE addresses this problem by enabling the project manager to set the threshold limits for the exception reports. This could be, for example, the critical activities and any other activities that are running late, over budget or not meeting the required specification.

The project manager's job title and role in the organisation

If a company organisation is searched to find a project manager, the first results might be fruitless because no one with that job title could be found. The project manager's identity is often hidden behind some other organisational role. This is particularly true for specialised, in-house projects where, for example, a person with the title 'facilities manager' might act as project manager during a big reorganisation of accommodation. Another example is where someone styled ‘senior engineer’ is made responsible for managing a costly new product design and development project.

Even where project management is accredited with the importance of full-time appointment, the situation can be made less clear by the variety of titles used to describe the job. Contract manager, scheduling and estimating manager, project coordinator, project coordination engineer, program engineer, project leader and project manager are but a few of the titles which have been used. The trend in recent years has been encouraging and project management is now widely recognised as a profession that deserves reasonable status and rewards, with its own professional associations and with far less confusion over the job title.

A project manager might have started as an information technologist, a specialist in one of the operational research disciplines, a contracts manager or a qualified engineer. One of the more common routes to project management lies through the engineer design department. Frequently the engineer in command of a particular project design is charged with some degree of responsibility for seeing the entire project through to completion. When this happens, has a dual organisational position, exercising direct line authority and supervision over the design staff, while acting only in a functional role when trying to influence all the other departments engaged on the project.

The project manager function in a small company might be conducted entirely on a part-time basis by one of the existing department heads, or by one other individual as in the case of the engineer just described. Other companies could be forced to recognise the need for a full-time project manager, the incumbent being held responsible for either one individual project or for several projects which are being handled simultaneously.

Planning and Scheduling

The planning and scheduling environment

The planning and scheduling environment is illustrated in the diagram on the next page.

External factors

External factors are events and conditions that lie outside the control of the project management organisation. Some of these factors can affect or completely wreck attempts at project planning. The following paragraphs list a few examples for the many possibilities.

Acts of God: All projects are subject to risk, and many of those risks can have an enormous impact on plans. The following are just four forms the long catalogue of happenings that can be classified as Acts of God:

- An earthquake devastates a project organisation’s headquarters
- A hurricane and flood put a project site under a meter of water and delay the start or ruin the work in progress.
- A flu epidemic puts half of the project workforce out of action

Fiscal policy: Fiscal policy which is the policy of a national government in respect of taxation and other financial measures, can have a profound effect on projects and their planning. One extreme manifestation of this is when a government-funded project is cancelled or abandoned through a political decision (defence projects are a prime example). Less immediate, but of more general concern, are the wider and longer term economic consequences of government policy that can lead to project downscaling, delays and cancellations in all sectors of the industry.

Corporate strategy: Strategic decisions made by managers outside and above the project organisation can affect many aspects of planning. Here are a few examples:

- A decision is made at the top management level of a group of companies to conduct a project in a different company within the group from that originally intended.
- A decision is made to delay the start of an internal project owing to diversion of funds for other purposes.
- A strategic decision is made to halt all new staff recruitment, so reducing the resources previously expected to be available for projects.

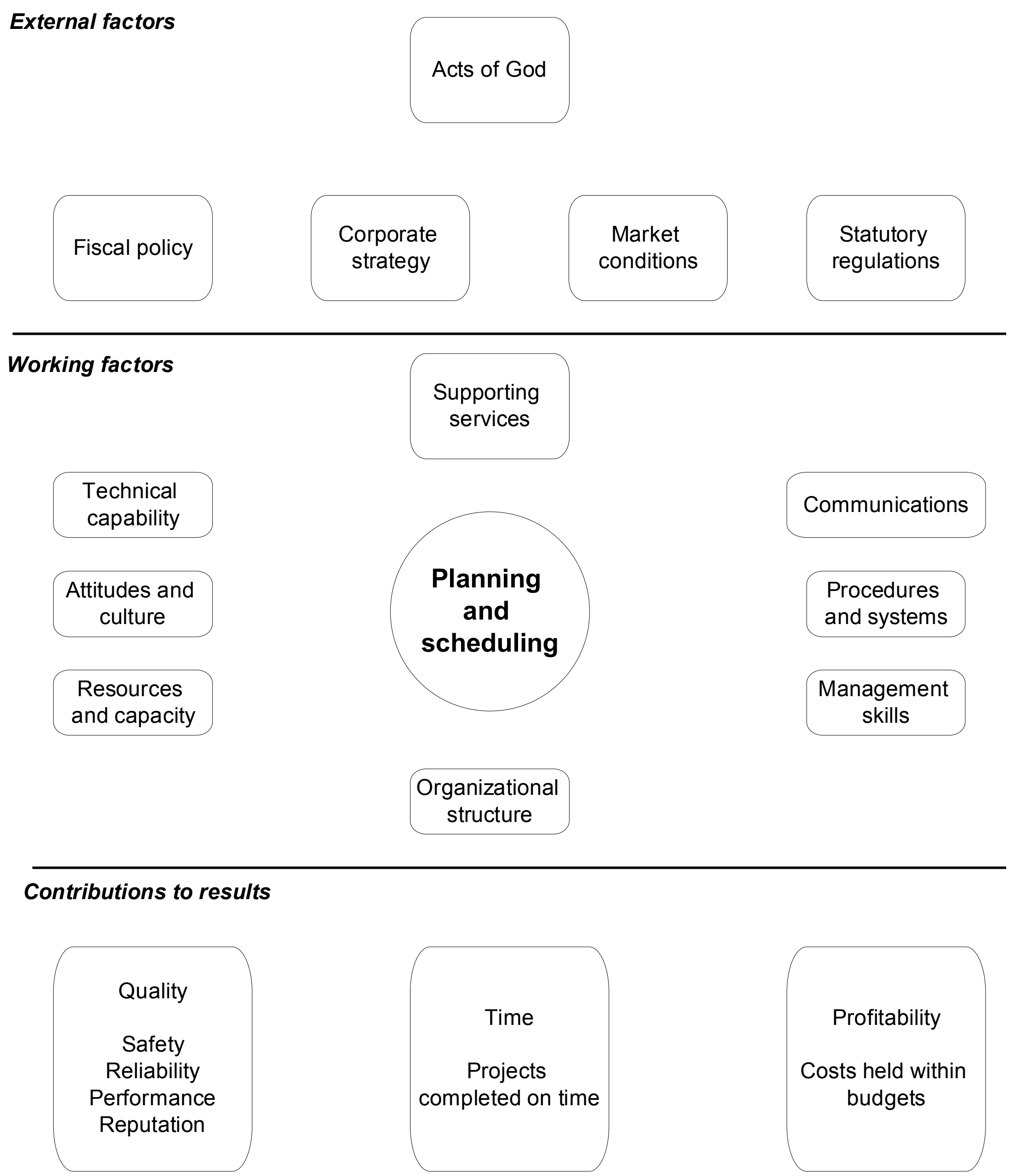
Statutory regulations: Legislation by national and regional governments can impose extra burdens on project designers and contractors which have to be taken into account at the planning stage. This can be particularly important feature of projects carried out in foreign countries, where the project manager would need to research the local employment, welfare, technical and commercial regulations before committing resources to a plan.

Working factors

The items labelled working factors in the figure are those most likely to affect the project manager and the project plans on a routine, day-to-day basis. The factors shown in the figure should be self-explanatory. Although responsibility for these items usually lies with managers close to the project organisation, they might be outside the control of the project manager, who has to learn to accept and plan accordingly.

Contributions to results

Effective planning and scheduling, because they provide a sound basis of progress management, should promote efficient working. Project personnel who are not constantly trying to overcome crises caused by bad planning can devote more their time to achieving the quality standards expected. A well-planned project stands more chance of being completed on time and this, in turn, should contribute greatly to cost



effectiveness and higher profitability.

Distinction between planning and scheduling

In project management terminology, some professional planners recognise that the words 'plan' and 'schedule' can have different meanings. We have found it convenient to observe the following distinction.

A plan can be considered as the listing or visual display that results when all project activities have been subjected to estimating, logical sequencing, target timing and the determination of priorities. For projects of any significant size, some form of network analysis is usually the preferred method for preparing a plan. However, some of the charting methods provide better visual aids, can be more effective for communicating plans to project personnel and are often quite adequate for small projects.

A schedule is obtained by doing additional work on the initial plan, so that resources needed to carry out all the project activities are taken into account. In other words, a schedule is the working document that results from matching the organisation's available resources to the initial plan.

The planning time frame

Planning (and scheduling) can be considered from two opposite viewpoints:

- A set of estimates could be obtained and used to produce a plan that predicts a project completion date that is then accepted by everyone as the goal. Suppose we call this the free planning approach.
- The end-date requirement is predetermined, governed by factors outside the planner's control. A delivery promise might already have been given to a customer in a sales proposal, or the project might have to be finished in time for a forthcoming exhibition or public event. This can be called the target – led planning approach.

The free planning approach:

Schedules produced entirely from estimates, with no external pressure to compress the timescale, should allow the planner to develop a working schedule that is capable of being achieved with certainty. There is no need to overstretch any person or resource in the project organisation. This might be regarded by some as an ideal state of affairs. However, a new project plan made with no external pressure whatsoever will probably predict an end date that is ludicrous from the customer's point of view, destroying any possibility of gaining a valuable order.

Completely free planning therefore has it dangers. Pressure to find ways of completing a project reasonably quickly is not such a bad thing, because time is money and projects which are allowed to drag their feet tend to attract higher costs from fixed overheads and other causes. Giving planners complete freedom to dictate the project timescale might, therefore, not be quite so advisable as it at first seems.

Target-led planning:

If a plan has to be suited to a predetermined, target delivery requirement, all the estimates must be fitted into the available time frame as best they can.

One temptation that must be resisted is for estimates to be shortened for no better reason than that the time available is too short. Another danger is of removing all possible reserves (e.g. by planning to work overtime or seven-time weeks) so that the plan is too tight and leaves no room for error. Of course, it is sometimes possible to reduce times by allocating more resources, but never must the project manager be persuaded or coerced into trying to expedite a plan simply by marking down estimates without any justification. Any honest person will admit that projects planned on this artificial basis are unlikely to be finished on time. Such optimistic plans can gain a temporary advantage by serving to pacify higher management or by deceiving a trusting customer into placing an order. Unfortunately the truth is bound to emerge sooner or later, bringing discredit on the project contractor.

Most planning is, however, time constrained. If the time available is restricted, particular ways have to be found for compressing the project timescale. One way is to examine the sequence of jobs critically and rearrange or overlap them to shorten the total time. A technique called fast tracking uses this approach intensively, but without creating unacceptable risks. Another approach is cost-time optimisation. For maximum effect, fast tracking and cost-time optimisation can be combined.

What happens if the target time for a new project is set later than strictly necessary, sot that the project plan is relaxed and stripped of all urgency? This would be rather unusual, but not impossible. Such extended schedules are an ideal breeding ground budgetary excesses according to Professor Parkinson's best-known law, where 'Work expands so as to fill the time available for its completion' (Parkinson's Law or the Pursuit of Progress, John Murray, London, 1958).

Resource limitations can complicate target-led planning. The usual problems occur because the initial plan is made without reference to available resources. Then, much later, work schedules are produced that are impossible to achieve, because the resources needed are either not there or are being used on other projects in the organisation.

The ideal approach:

In the best plans, the constituent elements are reliably estimated and arranged in their most logical sequence. Careful cooperation between the key participants in the proposed work is required, all striving to meet the needs of the customer and balancing these with the capabilities and resources of the project organisation.

Benefits of a project planning and control system

One of the main responsibilities of the project manager is to plan, track and control the project to meet preset objectives. To do this effectively the project manger requires accurate and timely information. This information should be supplied by the project's planning and control system, which outlines the scope of work and measures performance against the original plan.

Companies sometimes resist using project planning and control techniques because of the additional management cost. However, it should be appreciated that lack of information could be even more expensive if it leads to poor management decisions. Listed below are some of the main advantages associated with a fully integrated project planning and control system:

- Estimating: The performance of the current project will form the estimating data base for future projects. If this data is not collected by the planning and control system it may be lost forever.
- CPM: Critical Path Method (CPM) forces the managers to think about planning in a structured manner, the critical activities give a guide to the level of detail. The CPM presentation offers a tool for discussion with the other managers.
- Quality vs. Quantity: Too much data but insufficient information may be generated on a regular basis if the reports are not structured and summarised. CP an MBE can be used to provide focused information.
- Project/corporate system integration: the planning and control system can provide the link between the project and corporate reporting systems. Without this link double processing may be necessary to satisfy the information needs of both systems.
- Response time: timely response on project performance is essential for effective project control. The planning and control system can adjust the feedback to address the needs of the project. However the corporate systems like the accounts department are set in a monthly reporting cycle where feedback on invoices, for example, may be 4 to 6 weeks behind time now.
- Reporting interfaces: The planning and control system's data base can be structured around the Work Breakdown Structure (WBS) for project reporting and around the Organisation Breakdown Structure (OBS) for corporate reporting. Without this integrated system the two reporting requirements would have to be processed separately.
- Trends: Projects are best controlled by monitoring the progress trends of time, cost and performance. This information may not be available to the project manager if the trend parameters are derived from a number of functional sources.
- Data Capture: If the project progress reporting is based on information supplied by the functional departments, the project manager cannot control the accuracy of this information. The problem here is that it may only become obvious that the reporting is inaccurate towards the end of the project, when it could be too late to bring the project back on course to meet its objectives.
- Responsibility: If the project manager is to be held as the single point of responsibility his authority should be commensurate with this position. Therefore when the project manager accepts this responsibility, he needs authority over the supply of project information.
- Cost of mistake: To implement a fully integrated project management system will certainly increase the project office budget. However, without an effective planning and control system the cost of mistakes due to lack of adequate control may be even higher.
- Procedures: The planning and control system enables the project manager to develop procedures and work instructions tailored to the specific needs of the project.

- Client: The project manager is the project's single point of responsibility and the company's representative to the client. When holding meetings with client the planning and control system will provide information about every aspect of the project.

The above points outline the benefits of an independent project management planning and control system to give the project manager the best opportunity to effectively plan, monitor and control the project. Unfortunately, it is not always possible to substantiate these benefits financially as many of them like good customer service are intangible.

Bar Charts and Gantt Charts

Bar charts derived from Gantt charts, named after their originator, the American industrial engineer Henry Gantt (1861-1919). They have long been in widespread use, and they continue to be very valuable planning aids. Bar charts are not only easy to draw or construct and interpret but readily adaptable to a great variety of planning requirements.

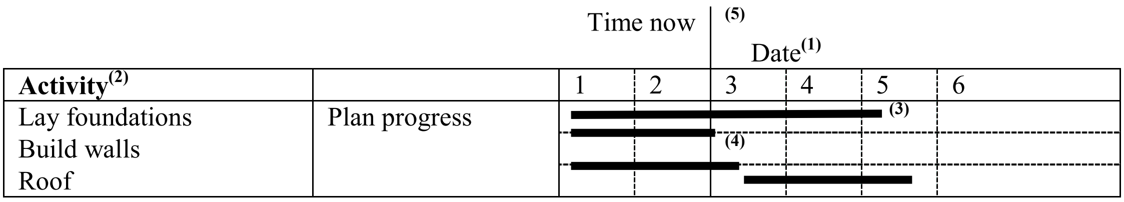
With the advent of more sophisticated planning methods, notably critical path network analysis, bar charts fell into undeserved disrepute. Although more modern techniques must be preferred in many cases, the older charting methods still have their valuable uses. Planning by bar charts is infinitely better than no planning at all.

The visual impact of a well-displayed schedule can be a powerful aid to controlling a simple project. Bar charts are still preferred to other methods in many executives' offices, on project sites and in factories. All levels of supervision and management find them convenient as day-to-day control tools. Even when projects have been planned with advanced computer techniques, the same computer systems are often used to plot the schedule data as bar charts for day-to-day use.

Figure 5.1 indicates the format of a Gantt bar chart, where the top and base are calendar time-scale in days (1) and the activities (2) are listed on the left. The scheduling of each activity is represented by a horizontal line (3), from the activity's start to finish date. The length of the activity line is proportional to its estimated duration.

Once the project has started the Gantt chart can further be used as a tool for project control. This is achieved by drawing a second line under the planned schedule to indicate activity progress (4). The relative position of the progress line to the planned line indicates percentage complete and remaining duration, while the relative position between the progress line and Time now (5) indicates actual progress against planned progress. The benefits of the Gantt chart can be clearly seen, not only are the calculations simple but it combines all the above information on one page.

Figure 5.1: Gantt Chart



Network Diagrams

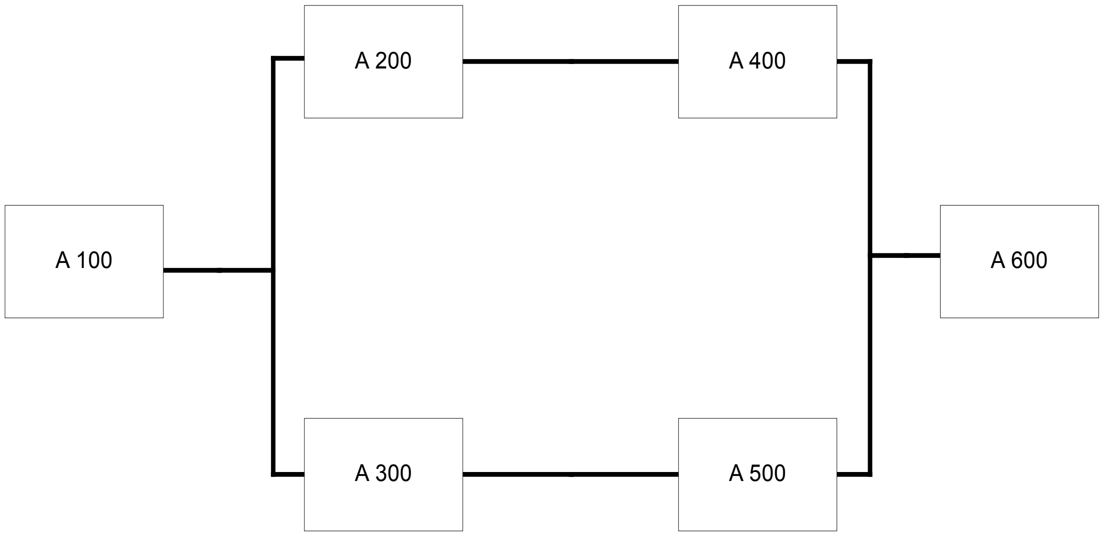
For a project plan to be effective it must equally address the parameters of activity time and network logic. As project became larger and more complex, the Gantt chart was found to be lacking as a planning and control tool because it could not indicate the logical relationships between activities. This logical relationship is required to model the effect schedule variance will have downstream in the project.

In the 1950's feedback from industry and commerce indicated that project cost and time overruns were all too common. It was suggested at the time that the project estimates were on the optimistic side in order to gain work. However a more important reason emerged which indicated that the planning and control techniques, available to manage large complex projects were inadequate.

With these shortcomings in mind, network planning techniques were developed by Flagle, the US Navy and Remington Rand Univac. Flagle wrote a paper in 1956 on 'Probability based tolerances in forecasting and planning'. Although it was not published in the Journal of Industrial Engineers until April 1961, it was in a sense the forerunner of the US Navy's Program Evaluation and Review Technique

(PERT). Both PERT and Remington Rand Univac's Critical Path Method (CPM) used a similar network format, where the activities are presented in boxes and the sequence of the activities from left to right show the logic of the project.

Figure 5.2: Network Diagram



Activity duration

The main difference between PERT and CPM was how they addressed activity time durations. The accuracy of an activity's time estimate usually depends on the information available from previous projects. If an activity has been performed before, its duration should be accurately predicted. However, activities with a new scope of work, which are difficult to measure or dependent on other uncertain variables, may have a range of possible time durations.

CPM uses a deterministic approach, which suits a project whose time durations can be accurately predicted e.g. a construction project. PERT on the other hand uses a probabilistic approach, which suits a project whose time durations may vary over a range of possibilities, e.g. a research project.

PERT

The PERT technique was developed to apply a statistical treatment to the possible range of activity time durations. A three time probabilistic model is developed, using pessimistic, optimistic and most likely time durations. The three time estimates are then imposed on a normal distribution to calculate the activity's expected time.

For PERT, three time estimates are required for every activity:

t_o= the most optimistic duration that could be foreseen
t_m= the most likely duration
t_p= the most pessimistic duration

From these quantities a probable duration is calculated for each activity on a statistical basis, assuming that the errors will fall within a normal distribution curve when all the project activities are taken as the sample.

The expected time is:

$$t_e = \frac{t_o + 4t_m + t_p}{6}$$

This calculation is repeated on all activities in the network and used to predict the probability of completing the project within the scheduled time.

When more than about a hundred separate activities are included in the network a computer becomes necessary to remove the drudgery from the calculations and enable the results to be made available in time for appropriate action to be taken.

Some authorities do not accept that the normal distribution curve is suitable for predicting the spread of estimating errors. It is well know that estimates are frequently too optimistic rather than too pessimistic. Whichever statistical basis is chosen, PERT will produce a critical path in the same way as any other network analysis method.

The success of the Polaris Submarine project helped to establish PERT in the 1960s as a planning tool within many large corporations. There were, however, a number of basic problems, which reduced PERT's effectiveness and eventually led to its fall from popularity. These included:

- Statistical analysis was not generally understood by project managers
- Computer technology limitations; batch card input and systems were not interactive and had a slow response

PERT is currently enjoying a renaissance as a tool to address risk management.

Critical path method

The Critical Path Method was developed in 1957 by Remington Rand Univac as a management tool to improve the planning and control of a construction project to build a processing plant for the Du Pont Corporation.

CPM was initially set-up to address the time cost trade-off dilemma often presented to project managers, where there is a complex relationship between the project time to complete and cost to complete. CPM enables the planner to model the effect various project time cycles have on direct and indirect costs. Shortening the project duration will reduce indirect costs, but may increase the direct cost. This technique is often called project crashing or acceleration.

The initial growth of CPM in the industrial market was slow, this was partially due to the lack of project management education and CPM training offered at the time by the universities and colleges.

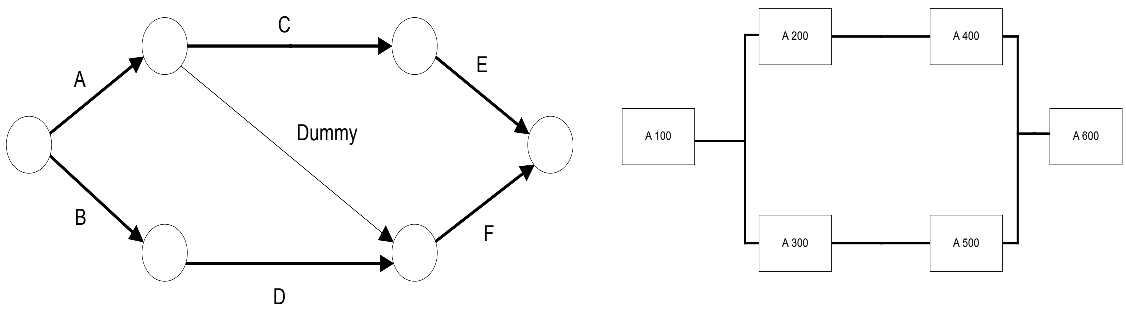
The early differences between CPM and PERT have largely disappeared and it is now common to use the two terms interchangeable as a generic name to include the whole planning and control process.

ADM or PDM that is the question

There are two basic networking techniques called:

- Arrow Diagram Method (ADM) also called Network-On-Arrow
- Precedence Diagram Method (PDM)

Figure 5.3: Two Basic Networking Techniques



Arrow Diagram method **Precedence Diagram method**

The basic difference between the two network diagrams is that with ADM the activity information is written on the arrow or rational link, while in PDM the activity information is positioned in the node or box. After carrying out the activity calculations, both methods will produce exactly the same result.

There are many practitioners who swear by their preference whether it be ADM or PDM. To be fair, both techniques have their benefits. Noting the market trends PDM has now established itself as the most popular planning technique, especially since the recently introduced project management software have adopted PDM as their standard.

Critical Path Analysis Using Arrow Diagrams

The heart of any activity-on-arrow system is the arrow diagram, logic diagram or 'network' itself. This differs from the more familiar bar chart in several important respects. Arrow diagrams, in common with all other network methods are not drawn to scale. Every network is, however, constructed with careful thought to show as accurately as possible the logical relationships and interdependence of each activity or task with all the other activities in the project. Indeed, it is for this reason that networks are sometimes called logic diagrams.

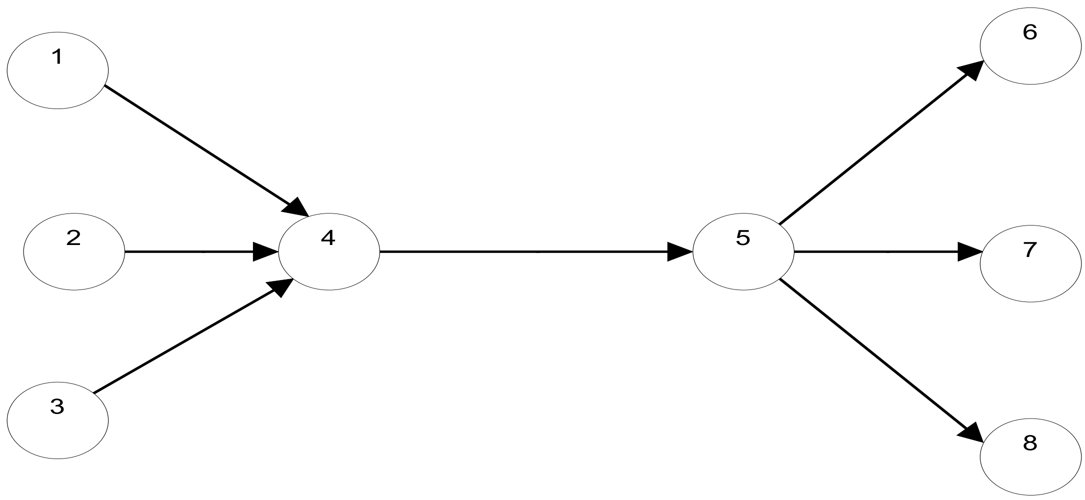
- **Jargon**

The strange terms have their origins in the mathematical theory of networks. In this alternative language, the circles are termed nodes and the arrows become arcs. The first event circle of an activity (the preceding event) is called the I node for that activity, and the end event circle (the succeeding event) is called its J node. Arrow networks are occasionally referred to, therefore, as IJ networks. This jargon is by no means essential to the understanding and application of project network analysis, but the terms crop up occasionally in the literature.

- **Activities and events in arrow diagram**

Figure 5.4 shows a very simple arrow diagram. Each circle represents a project event. An event might be the start of a project, the start of an activity (or task), the completion of a task or the end of a project. The arrow joining any two events represents the activity or task that must take place before the second event can be declared as achieved. Events are usually shared between tasks, so that a single event might signal the completion of several tasks and the start of one or several more tasks. In the figure it is obvious, therefore, that seven activities link eight events.

Figure 5.4: The Main Elements of Arrow Network Logic



Each circle represents a project event, such as the start or finish of a project activity. The arrow joining any two events denotes the activity or time needed for the project to progress from one event to the next. The numbers inside the circles are put there to identify the events. Activities are identified by their preceding and succeeding event numbers, so that the central activity in this example would be called activity 4 to 5. No activity can start until all activities leading into its start event have been completed. In this example activity 4 to 5 cannot be started until event 4 has been achieved or, in other words, until activities 1 to 4, 2 to 4 and 3 to 4 have all been completed. Similarly no activity following event 5 can start until activity 4 to 5 is finished. Networks do not need to be drawn to any timescale and the length of an arrow has no significance.

- **Direction**

By convention, activity arrows are drawn from left to right. This means that the arrowheads are not strictly necessary and could be omitted. Occasionally, perhaps when a network is altered or through lack of space on a page, it might be impossible to avoid drawing an arrow going vertically or even from right to left. In those exceptional cases the arrowheads must be shown so that there can be not ambiguity about the direction of any arrow.

- **Scale**

Unlike bar charts, network diagrams are not drawn to any scale. The length of the arrows and size of the event circles have no significance whatsoever.

- **Identification number in arrow diagrams**

The numbers in the event circles are there simply to label the events: they allow the events and their associated activities to be referred to without ambiguity. In Figure 5.4 the arrow from event 1 to event 4, for example, can be described as activity 1 to 4.

- **Logical dependencies and constraints in arrow diagrams**

In any arrow diagram, no event can be considered complete until all activities leading into it have been finished. Likewise, no activity can start until its preceding event has been achieved. This point can be demonstrated by reference to the figure. Event 4 cannot be considered as being reached or achieved until all three activities leading into it form the left have been achieved. When event 4 has been achieved, but not before, activity 4 to 5 can start. Activities 5 to 6, 5 to 7 and 5 to 8 must all wait until activity 4 to 5 has been finished before they can start.

Applying the arrow diagram method to an everyday 'project', suppose it is planned to plant a tree in a garden. If an arrow diagram were to be drawn, the result would look something like the sequence shown in the figure below. The interdependence of activities is clear in this case, and only one sequence of events is possible. The tree cannot be placed in the hole before the hole has been dug, and there would be little point in filling in the hole before putting in the tree.

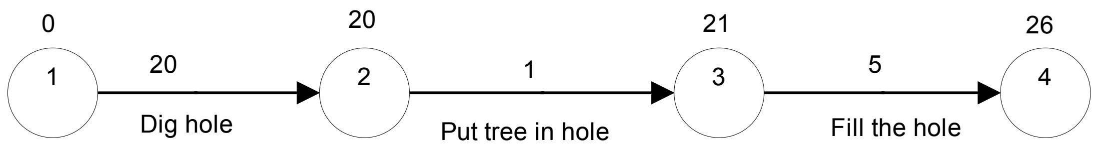
- **Activity duration estimates and descriptions**

Estimates for the duration of each activity have been made for the simple tree project, as follows:

Activity	*Description*	*Estimated duration*
1 to 2	Dig the hole	20 minutes
2 to 3	Position the tree	1 minute
3 to 4	Fill in the hole	5 minutes

No one needs network analysis to realise that this project is going to take a minimum of 26 minutes to complete (See Figure 5.5). Notice, however, that the estimated duration is written above each activity arrow, with a concise activity description written below. Space on networks is usually limited so experienced planners become adept at describing tasks in the least possible number of words.

Figure 5.5: Tree Project Network using arrow notation



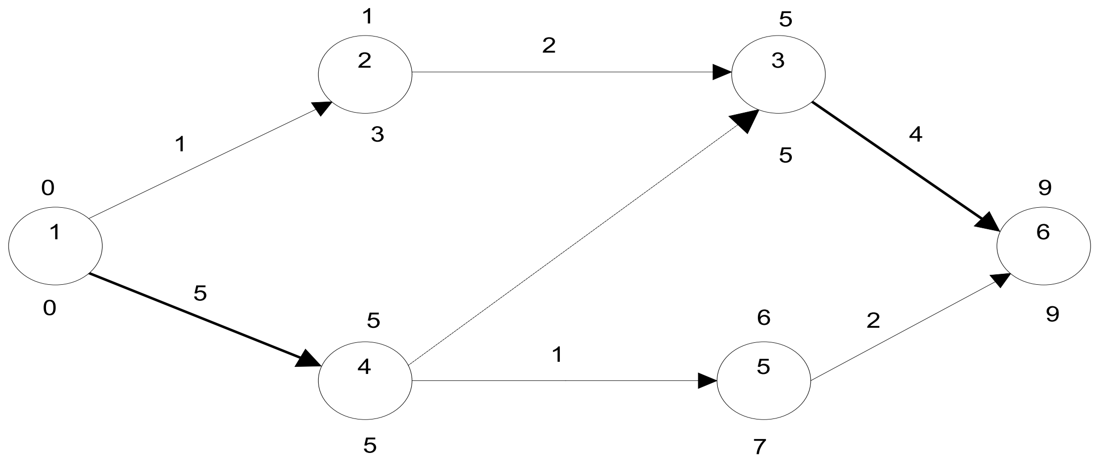
The numbers written above the activity arrows in this extremely simple example show the estimated duration of each project task. Minutes have been used in this case but any time units can be used provided that the same units are used throughout the network. Days or weeks would be more usual units for an industrial or commercial project. The numbers written above the events circles are calculated by adding the estimated activity durations from left to right. They show the earliest possible time by which each event could be achieved.

- **Dummy activities**

The network in Figure 5.6 below represents a slightly more complex project. Now the configuration is actually seen to be a network of activities, and not just a simple straight-line sequence. In this example, as in all real project networks, there is more than one path through the arrows to project completion. In fact there are three possible routes here to the final event 6, one of which flows through the dotted arrow linking event 4 to event 3.

Dummy activities do not represent actual work and practically always have zero duration. Rather, they denote a constraint or line of dependence between different activities. In the figure, therefore, the start of activity 3 to 6 is dependent not only upon completion of activity 2 to 3, but it must also await completion of activity 1 to 4. Alternatively expressed, activity 3 to 6 cannot start until events 3 to 4 have both been achieved.

Figure 5.6: An example of Arrow Network time analysis



The dotted arrow in this network is a dummy activity. As already seen in the tree project, numbers written above event circles show the earliest possible time by which events can be achieved, calculated by adding all the activity durations from left to right. Where there is more than one possible path, the longest must determine the earliest possible event time. In this case, the earliest time for event 3 is dependent on the path through the dummy. The numbers below the event circles have been found by subtracting activity durations from right to left from the final event, again taking the longest path. These numbers are the latest permissible times by which each event must be achieved if the completion time for the whole project is not to be delayed.

- **Time units for activity duration**

In the figure (as in the simple tree project) numbers have been written above the activity arrows to show their estimated durations. The units used are always chosen by the planner as being the most suitable for the project. In the tree project, minutes were the most appropriate unit of time, but days or weeks are the units most often used for project plans. The best modern computer programs will, however, accept any unit of time for seconds to years.

- **The forward pass**

In the project network, the earliest possible time for each event, and finally, the earliest possible time for project completion at event 6 has been calculated by adding activity duration estimates along the arrows from left to right. This is always the first step in the full time analysis of any network and is known as the 'forward pass'.

The forward pass process is more complicated in this than it was in the simple tree project because there is more than one possible path through the network. The earliest time indicated for each event appears to depend on which path is followed, but only the longest preceding path will give the correct result. The earliest possible completion time for event 3, for instance, might seem to be 1 + 2 = 3, if the path through events 1, 2 and 3 is taken. Event 3 cannot be achieved, however, until the end of week 5 because of the longer path through the dummy. This also means that the earliest possible start time for activity 3 to 6 is the end of week 5 (or, for more practical purposes, the beginning of week 6).

Thus the earliest possible time for any event is found by adding the estimated durations of all preceding activities along the path that produces the greatest time. By following this procedure through the network to the end of the project at event 6 it emerges that the earliest possible estimated project completion time is nine weeks.

- **The backward pass**

Now consider event 5 in the figure. Its earliest possible achievement time is the end of week 6, three weeks before the earliest possible time for finishing the project at event 6. It is clear that activity 5 to 6, which is only expected to last for two weeks, could be delayed for up to one week without upsetting the overall timescale. In other words, although the earliest possible achievement time for event 5 is week 6, its latest permissible achievement time is the end of week 7. This result can be indicated on the arrow diagram by writing the latest permissible time underneath the event circle. The result is found this time, not by addition from left to right along the arrows, but in the opposite way by subtracting the estimated durations of activities from right to left (9 – 2 = 7 for event 5).

This subtraction exercise can be repeated throughout the network, writing the latest permissible times below all the event circles. Where more than one path exists, the longest must be chosen so that the result after subtraction gives the smallest remainder. This is illustrated at event 4, where the correct subtraction route lies through the dummy.

Although the earliest and latest times are written above and below the event circles, they can also be applied to the activities leading into and out of the events. Thus, for example, activity 5 to 6 has:

- Estimated duration: 2 weeks
- Earliest possible start: end of week 6 (beginning of week 7)
- Earliest possible finish (6+2): end of week 8
- Latest permissible finish: end of week 9
- Total float (9-8): 1 week

The term float indicates the amount of leeway available for starting and finishing an activity. The word slack is also used sometimes (it means the same as float).

- **Critical path**

When all the earliest possible and latest permissible time have been added to the diagram, there will be at least one chain of events form the start of the network to the end where the earliest and latest event times are the same, indicating zero float. These events are critical to the successful achievement of the whole project within its earliest possible time. The route joining these events is not surprisingly termed the critical path. Although all activities may be important, it is the critical activities that must claim priority for resources and for management attention.

Time Cost Trade-Off

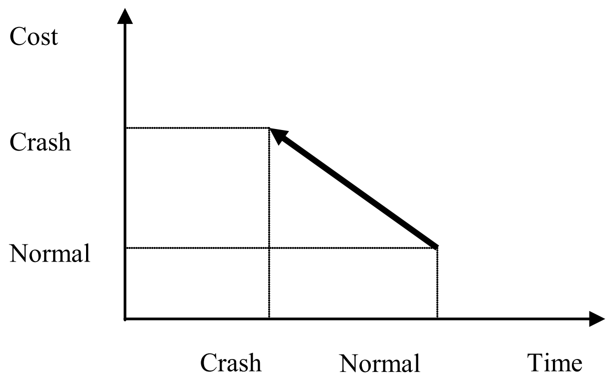
After completing the network diagram and the CPM calculations, the next step is to critically examine and evaluate the quality of information being provided for the decision support function.

The purpose of time cost trade off may be explained as developing the schedule that just balances the value of the time saved against the incremental cost of saving it. In simpler terms, this means when a power plant, for example, is taken out of the service its ‘opportunity cost’ or lost income can be quantified per day. If an overhaul could be reduced by a few days, is the income for the time reduction greater than the cost of crashing the project?

Project acceleration, also called crashing, is the process of reducing the duration of a project.

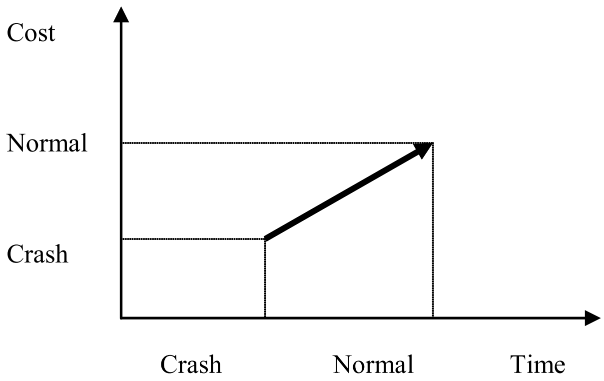
Some definition:
Normal time: normal office hours, 8 hours a day, 5 days a week
Normal cost: the cost of the activity working normal hours
Direct cost: costs attributed directly to the project, labour and materials. These costs usually go up when the activity is crashed due to overtime, shift allowance etc.
Indirect cost: overhead costs which cannot be directly attributed to the project for example, office rent and management salaries. These costs are usually linear with time, therefore, if the time reduces, the indirect costs also reduce.
Crash time: the duration the activity can be reduced to, by crashing the activity
Crash cost: the new cost of the activity after crashing
Crashing (direct costs): the duration has been reduced but the costs have increased. These additional costs are caused by overtime, shift work and a reduction in productivity.

Figure 5.7: Crashing Direct Costs



Crashing (indirect costs): The duration has been reduced but this time the costs have also reduced. The benefit has come form reduced office rental, equipment hire, etc. Unfortunately project costs are usually split 80% direct, 20% indirect so that benefit of crashing indirect costs is usually overwhelmed by the far greater direct costs.

Figure 5.8: Crashing Indirect Costs

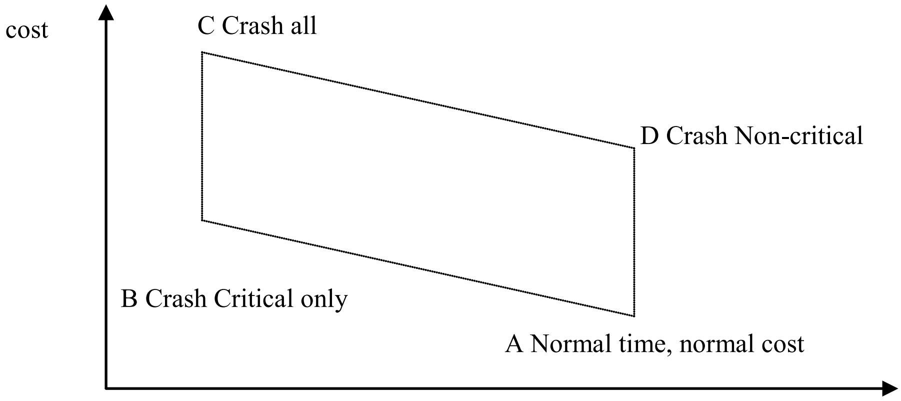


Time cost trade-off: The time cost trade-off figure outline graphically four different time cost positions. Staring at point A, this point represents normal time and normal costs. Consider first the effect of crashing all the non-critical activities, the project will move to point D. Notice there has been no shortening of the project's duration, but the costs have increased dramatically. This is not a recommended course of action as it only increases the float of non-critical activities.

The correct action would be to crash all the critical activities. The project moves to point B. Crashing the critical activities has reduced the duration of the project with a small increase in costs.

The fourth point on the graph, C, indicates the position when all the activities are crashed. Again this is not recommended because there has been no time improvement on point B, yet the costs have increased tremendously.

Figure 5.9: Time Cost Trade-off



Example and Exercises

The figure shows a network with 12 activities (A, B, C, ….M) and 7 events. The figures on the arrows are the duration of the activities some convenient units. Activity E is a dummy.

How many paths are there through the network and what are their duration? Find the minimum project time, the critical activities and the total float for each non-critical activity.

What are the critical activities and minimum project time if:

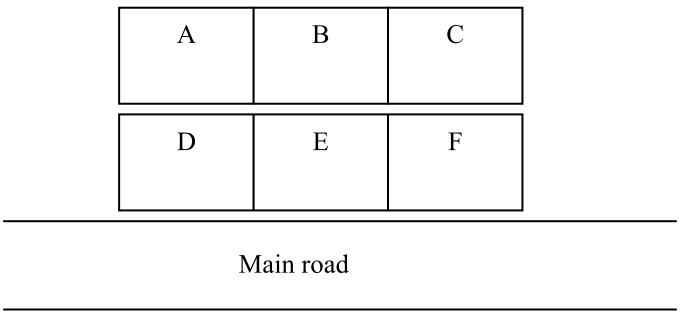
a) the dummy is removed
b) the duration of M is increased to 15 units.

Other exercises

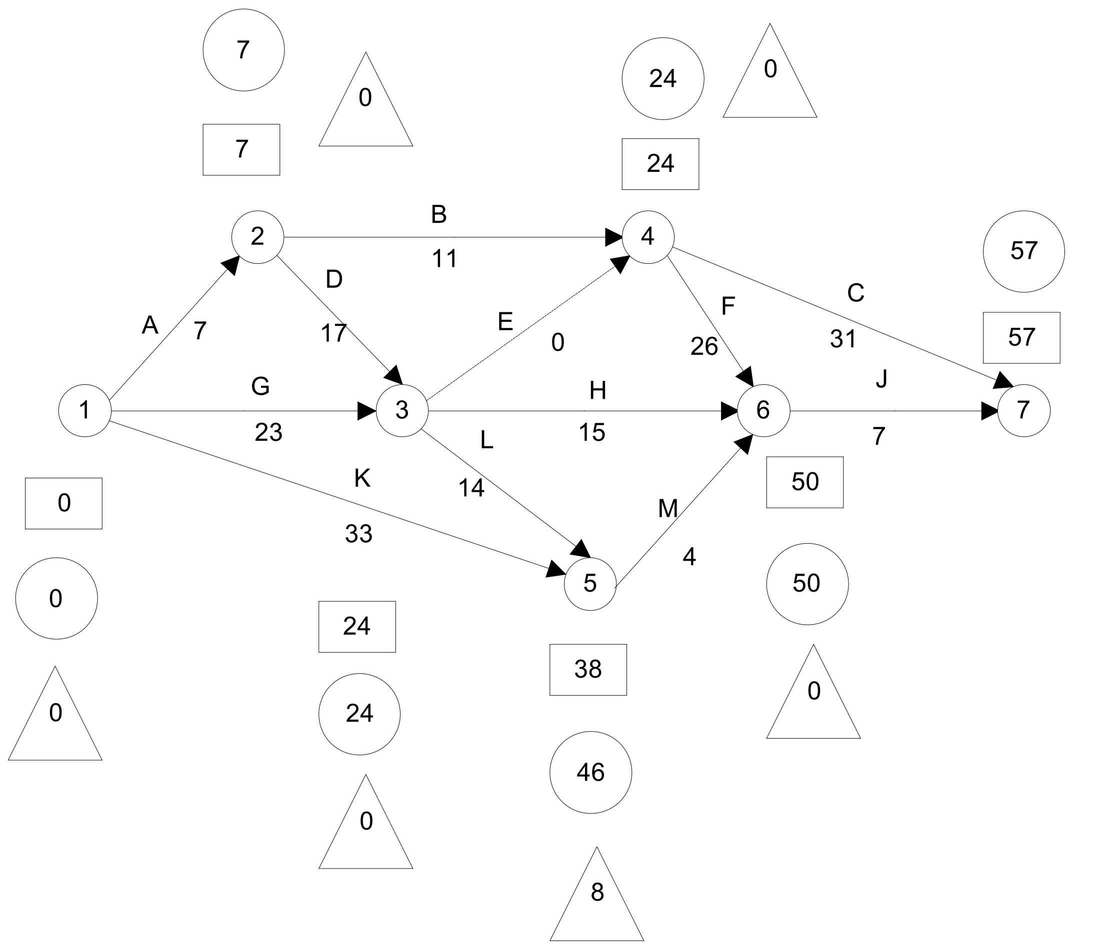
1. The figure relates to an urban redevelopment scheme, the present and proposed land use being as follows:

(a) A is a cleared site, ready for building;
(b) B, C, D and E contain derelict industrial buildings and some old housing whose occupants are to be relocated on A and B (at twice the present density);
(c) F is an old school, which is to be replaced by a new one on C;
(d) D, E and F will be used for widening the main road and providing amenity land.

The building programs for areas A and B are each divided in half (each half requiring 11 months) and, as



each half is completed, families from one of the areas B, C, D and E can be re-housed. It is anticipated that each move to the new areas will take 1 month. The new school on C is designed to use an industrial building system and will take 8 months to build.



Earliest possible event time
= max (TEkp + TA)
TEkp : TE of the previous event
TA: time of the activity

Latest possible event time
= min (TL kf - TA)
TL kf: TL of the following event
TA: time of the acitivity
and the TL of the finish event = TE of that event

Slack time: TE - TL of the event

The critical path is given by the activities relying the events for which TE = TL or whereby the slack equals zero.

Example
TE of event 2 is 0+ 2= 2
TE of event 3 is 0 + 23=23
TE of event 5 is Max (0+ 33 and 24 + 14) = 38

TL of event 7 is TE of event 7 is 57
TL of event 6 is 57 - 7 = 50
TL of event 4 is Min (57 - 31 and 50 - 26) = 24

Minimum project time: 57 days
Critical path: A - D - E - F - J

Building can only take place on one site at a time. Demolition is to be carried out by contract and 2 months is required for clearing each area, only one being dealt with at a time.

The road widening and landscaping is to be carried out in a single four-months contract.

List the activities to be carried out, together with their durations and preceding activities, draw a network and determine the time to complete the project. What are the critical activities?

2. Assume that you are letting a contract for widening a street. Draw a PERT diagram for the activities from the start of preparation of specifications until contractor go-ahead. Determine the critical path and the shortest time to complete the set of tasks.

Prepare a table showing the earliest start time, earliest finish time, latest start time, latest finish time, and slack time for each activity.

Task	*Description*	*Expected time (working days)*	*Immediate predecessors*
A	Prepare specifications for job	5	None
B	Notify property owners	2	None
C	Select prospective bidders	4	None
D	Contract prospective bidders	4	C
E	Send out requests for bid	3	A, D
F	Hold a bid conference	2	E
G	Secure property owners' approval	14	B
H	Wait for bidders to prepare bids	10	F
I	Receive bids	2	H
J	Evaluate bids	5	I
K	Prepare final job schedule	2	G, J
L	Arrange details with water company	4	G, J
M	Notify selected bidders	1	K
N	Negotiate and sign contract	2	L, M
	Go-ahead for contractor	0	N

- Construct a PERT diagram for the following information, and determine the critical path.

Activity	*To*	*Tm*	*Tp*	*Immediate predecessors*
A	1	2	4	None
B	2	4	6	A
C	2	6	10	A
D	6	8	10	B
E	4	6	8	C
F	6	10	14	C
G	8	10	12	D, E
H	12	14	16	F
I	4	8	12	G, H
J	10	12	16	G, H
K	2	4	6	I
L	6	10	14	J

Assume that the schedule allows 40 days to complete the whole project, and calculate the probability of completion by the scheduled date.

The contractor wants to quote a scheduled completion date that would give him a 90 percent chance of attainment. How many days should he allow in his schedule?

Managing Money

Money – or the lack of it – is one of the most frequently cited limitations in development, as a reason for delays, poor performance, and lack of maintenance. Even the other great bugbear – lack of skills – can ultimately be traced back to lack of funds for training and the appointment of top quality personnel, and, further back still, lack of funds for the education that underpins all training. The first part of this chapter will concern the problems of managing money from the point of view of the manager of a typical development project operated by staff of government or parastatal agencies and of NGO's (ie. NGOs which are not primarily trading or banking organisations); such organisations normally provide funds to cover expenditure, and require revenues to be returned to the central administration, so that the commercial problem of financing expenditure from cash flow plus borrowings does not arise.

Money management has two key aspects – setting targets and interpreting feedback; the following sections explore these in more detail.

Phasing expenditure budgets

One of the most difficult set of circumstances in which to plan expenditure is undoubtedly that of the development project, and the more complex the project, and the more agencies are involved, the worse the problem. However, the same fundamental principles apply for all such projects: expenditure is the result of physical activity, not its cause. That is, you have to plan physical activity and deduce financial activity from it; however, having done this, you may well find that overall progress is restricted by the 'money' resource. So, the implementation scheduling sequence runs like this:

- Compile an activity network, to get a complete list of activities in proper sequence.
- Draft a preliminary implementation plan.
- Carry out any resource levelling necessary to ease peak demands for physical resources and personnel.
- Carry out any necessary 'crashing' to shorten the programme.
- Work out the rates of expenditure that result.
- If the rate of expenditure exceeds the available budget, revise the physical program (ie. the second step above) and repeat, bearing in mind the need to give priority for funds to critical activities.

Money is a slightly peculiar resource, in three ways. First, virtually all activities compete for it. Secondly, many activities generate a stream of costs that run on after the activity itself ceases; hiring staff generates a near-unstoppable stream of salary and welfare costs; renting premises similarly generates a stream of bills for rent (and usually for utilities also); installing plant generates a stream of maintenance costs, which, however, are often ignored in contravention of the sound maxim that a stitch in time saves nine. Thirdly, the pattern of money requirement is often much less even than the pattern of say, labour requirement. For example, payments for a piece of imported plant might be 15% on signature of contract, 15% on port clearance, two phased payments of 20% during installation, and the remainder divided between a payment on completion and a retention to cover defects appearing during the first season. Similarly, civil engineering and building works will generate a flow of staged payments (and occasionally, loans for the purchase of specialist plant), usually with a distinct peak in the middle of the contract, when the project is busiest. These make it difficult to level money requirements in the same way as can be done for labour. The trial-and-error approach is often used; and some of the more sophisticated computer programs offer facilities for treating finance as a resource.

The principles of the central step of this process – creating a phased expenditure forecast – are demonstrated using a simple example. It might not be a bad idea to repeat the working of this yourself.

The project centres on the upgrading of an existing abattoir, necessitating the construction of a plant to take in live cattle, sheep and goats; produce clean carcasses and offal; and convert most offal, blood, and other waste into feed-quality blood and bone meal. The plant is integral with its prefabricated shell; but a new water supply is required and is to be installed to supply water during construction. A program of road improvement was included in the scheme, mainly to handle an anticipated increase of output of meat in refrigerated transport (the increase being largely attributable to a separate and now successful initiative to encourage stall-feeding); however, the existing road is adequate for access for construction.

Figure 5.10 shows a bar chart for the project, with both the earliest (clear) and latest (shaded) possible for the non-critical activities. To create a unique forecast of expenditure, it would be necessary to fix the dates of the non-critical activities – probably at a little before late start. What Table 5.1 does is show the build up of expenditure for the two extreme situations: all non-critical jobs at early start and at late start respectively. In each case, the timing of the expenditure is taken from the bar chart, and the appropriate sum entered on the appropriate row (activity) for the appropriate month. These figures are then used to build up the extreme cumulative expenditure graphs, which are shown in Figure 5.11. (The steepness of the graphs and the 'fatness' of the zone between them are very dependent on choice of scale, of course.)

Figure 5.10: Bar Chart for Phased Expenditure example

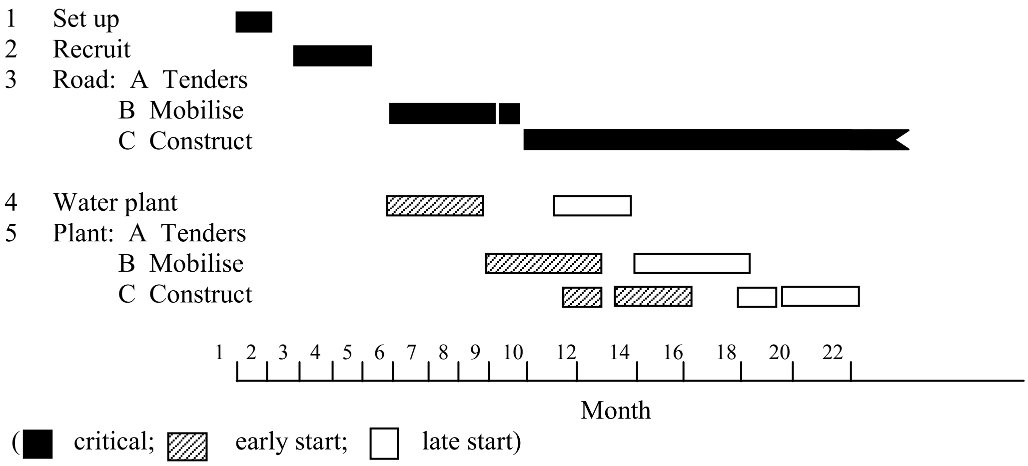
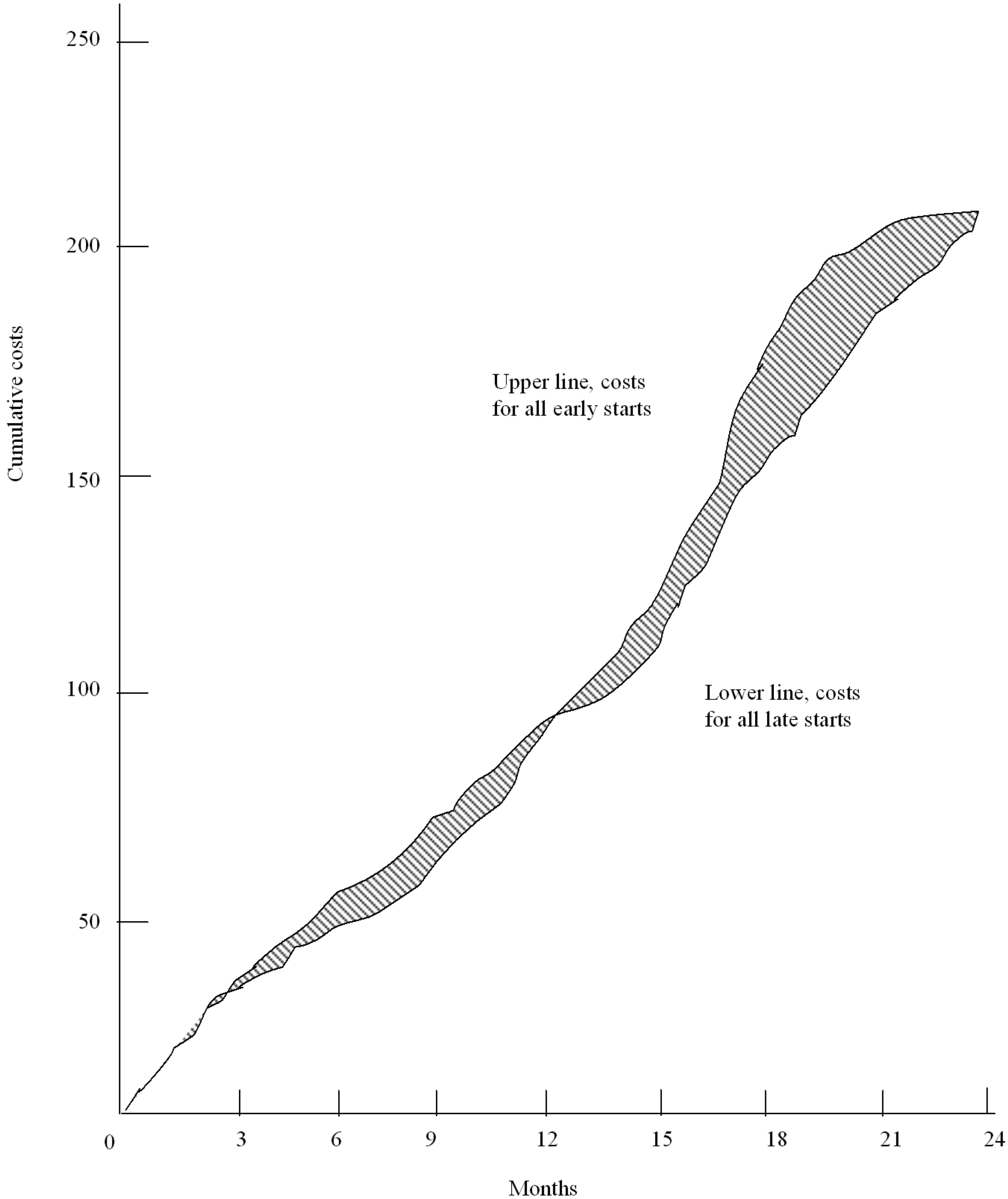


Table 5.1: Phased Expenditure Calculations (Costs in Thousands of Dollars x 1(X))

	Cost Item	Month																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
(A)	All Activities at early start																								
1*	Rents & Salaries		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	Salaries					3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3a	Advertising etc.							1																	
3b	Mobilisation	Nil																							
3c	Staged Payment											1	5	8	8	10	10	10	10	8	6	4	3		
4	Single Payment to PWD (advance)					9																			
5a	Advertising etc.										1														
5b	Mobilisation	Nil																							
5c	Staged Payment													5		15	5								
	Monthly Totals		3	3	3	15	6	7	6	6	7	7	11	19	14	31	21	16	16	14	12	10	9	6	6
	Cumulative Total		3	6	9	24	30	37	43	49	56	63	74	93	107	138	159	175	191	205	217	227	236	242	248
(B)	All Activities at late start																								
1*	Rents & Salaries		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	Salaries					3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3a	Advertising etc.							1																	
3b	Mobilisation	Nil																							
3c	Staged Payment											1	5	8	8	10	10	10	10	8	6	4	3		
4	Single Payment to PWD (advance)											9													
5a	Advertising etc.																1								
5b	Mobilisation	Nil																							
5c	Staged Payment																			5		15	5		
	Monthly Totals		3	3	3	6	6	7	6	6	6	16	11	14	14	16	17	16	16	19	12	25	14	6	6
	Cumulative Total		3	6	9	15	21	28	34	40	46	62	73	87	101	117	134	150	166	185	197	222	236	242	248

*Numbers and phasing correspond to those of Figure 5.11

Figure 5.11: Cumulative cost graph (upper line, costs for all early starts; lower line, costs for all late starts)



Interpreting expenditure data

In general, projects will have three expenditure lines: the early start expenditure line, the late start expenditure line, and the planned expenditure line. Expenditure control and monitoring is of course crucially important: it is necessary to ensure that money is spent in accordance with the spirit of the authorisations given, and it is also necessary to make sure that, in your zeal, you do not stray too far outside the letter of these authorisations, either! Unexpected large deviations from the plan may suggest the need to consult funding agencies (donor, Treasury, the NGO's sponsors) about either anticipated over-expenditure or anticipated delay of expenditure resulting from changes in the pattern of physical activity.

However, expenditure data is not a good management tool in itself. Even if the obvious pitfalls are avoided (eg comparing actual expenditure on a bills paid basis with a plan made on a sums committed basis, or comparing actual expenditure at face value with a plan made at constant prices) there is a fundamental flaw in the idea of expenditure rate as a primary monitoring tool. This arises from the distinction between expenditure on critical items and expenditure on non-critical items. It is tempting to assume that if the cumulative expenditure graph (like the one in Figure 5.11) is used as a control chart, and actual expenditure plotted on it, when the 'actual' line stays between the early start and late start cost lines, then all is well; and that when it returns into the zone between those two lines after having fallen below it, then successful remedial action has been taken. Neither assumption is reliable – in fact, the latter is almost totally fallacious. Consider the case of a project to build a facility for producing fingerlings (small fish to stock farmers' ponds). The critical path ran through the construction of ponds, and the production of the great grandparent, grandparent and parent generations of fish – but the Fisheries Department's construction team concentrated on building the headquarters' offices and library. As these were costly structures, the disbursement rates looked fine – but in terms of advancing the project towards production, virtually zero progress was being made. And, of course, the same applies with even more force to the situation where a low rate of expenditure is being pushed up over a relatively short period: the easiest way to do this is to bring forward non-critical expenditure.

These considerations make nonsense of the practice in many government departments of using disbursement rates (ie. expenditure actually made, as a percentage of planned expenditure) as an early warning device. Nevertheless, in many government agencies, the primary monthly progress check is just that, possibly supplemented by "bottleneck codes" – a list of code numbers for different assigned reasons for the possible delays indicated by an reduced expenditure. Without knowledge of the factors determining the cause of the underlying decline in physical activity, the assignment of these codes has to be highly subjective, and may well amount to little more than a reallocation of blame! On operational items, of course, (ie. regular expenditure on fuel, foodstuffs, and so on) for an established enterprise, relative rate of expenditure is a useful control tool.

A slightly better approach is to use expenditure rate on critical activities only – but to do this properly means knowing the current structure of the project, in terms of where the critical and non-critical paths actually lie. Given this knowledge, the sensible thing to do is to monitor physical activity, and report its impact on financial matters, rather than to use expenditure as a poor proxy measure of progress.

Financial records

The financial records required for controlling "official" expenditure are relatively simple, although there may be a large volume of them on a big project. For each expenditure heading, a record of the form shown in Fig 5.12 is needed:

Figure 5.12: Expenditure Record

Project................................ Expenditure Heading...

Date	Item	Amount Committed	Balance	Amount Paid	Remarks

The record is identified with the project name, and the heading (eg Khalistan Fisheries Project, Building Program 1998/90), and the sum allocated is written on the top line of the “balance” column. As expenditure is committed, it is entered – and, periodically, the balance remaining available for expenditure is reduced by the running total of the amounts committed. (It is, of course, committed expenditure that you have to watch.) Amounts paid are also entered when the transaction is complete, and a remarks column allows the rewarding of voucher numbers and comments on any unusual factors of the transaction.

Budgetary methods

So far, we have been concentrating on the way expenditure budgets are made up for individual projects; the ways in which programs of physical activity can be tailored to fit within budgetary limits, and the ways in which financial data can be collected and the limitations on its use as a control tool. However, there is another side of the budgetary story, and that is how allocations get made in the first place. This affects managers, and they, in turn, affect the process.

Looking at the national level first of all, budgeting is a heavily constrained process: there is always a very sizeable burden of costs resulting from earlier decisions that cannot readily be got rid of. Existing contracts, essential imports, and the salaries of government employees can mop up a very large slice of national income, leaving only a small percentage available for discretionary spending, particularly on new developments. As a result, much budgetary decision-making is essentially incremental, that is, marginal modifications and additions to an existing base. Attempts have been made to introduce zero-base budgeting (ZBB) in large governmental organisations (eg US Department of Agriculture). Under this system there is theoretically no expenditure item whose necessity is taken for granted and all significant expenditure has to be justified. It is very difficult to establish a rational basis for say, the relative proportions of money to be spent on vocational education, soil conservation policy, enforcing plant quarantine regulations, and extension – and impossible to repeat the exercise within the confines of each year’s budgetary timetable. As a result, successful introduction of zero-based budgets could open up a whole series of internal conflicts about the relative size of allocations, which usually result from combinations of historical accident and political pressure, ZBB has other costs, too – notably the deterioration in morale caused by the way it appears to threaten jobs and pet projects. Perhaps fortunately, what actually happens is that all concerned involve themselves in an orgy of justification of the status quo! This is not to say that periodic review of the usefulness of major sectors of official expenditure should not be made; however, this is a process that should be separate from the annual budgetary exercise.

This exercise is far from being a straightforward technical one. Normally starting from the very top, a formal request for preparation of the annual budget will be made; this will usually indicate the acceptable change on the previous year, often (for reasons similar to those that limit the scope of ZBB) on an across-the-board-basis, eg that amounts budgeted for salaries may not exceed 103% of the previous year’s amounts, or that capital expenditure must not exceed 95% of that in the previous year. One item that will be tabulated separately is the annual development budget (ADB), under which much of the discretionary margin between national income expenditure (adjusted by any planned deficit) is spent.

As the request goes down through government (and project agents), it becomes broken into finer subdivisions, by discipline and geographical area; plans are made and cases fought for special adjustments, and the tide of the budget slowly flows back up through the structure. As it does so, it bears with it a lot of managerial flotsam and jetsam in the shape of mismatches between planned physical activity and available budget. Much of this arises because of the large political element in the process. For example, items are often inserted in the budget more as a political statement about the desirability of an activity than with any serious intent of accomplishing anything – funds for family planning are often allocated on this basis. Secondly, the politics of the sharing-out of funds process can cut off funds in quite arbitrary ways. At one state, in Pakistan, foreign project aid was planned on the basis of the activities intended in the four provinces, and aggregated on a national basis – but then shared out between the provinces on a population-based principle which totally ignored the relative amounts of expenditure that should have resulted from planned project activities! It is far from unusual for individual departments and agencies to have annual development budgets that do not match the aggregate cost of planned project activity. Most project managers are unaware of this, and fail to make appropriate adjustments – indeed, where managers lack the basic skills of scheduling and controlling physical activity, the mismatch is hardly likely to stand out from the general chaos.

Project planners are also far from innocent in creating the mess. First of all, planners of large projects rarely take the trouble to find out how much of the available margin – the ADB – it is sensible to hope to be available for their particular brainchild, given the other political priorities in the system. (However good your ranching programme, if it needs 50% of the available development funds in a certain year, it is unlikely to get them if the whole of the agriculture sector normally only gets say 65%.)

Secondly, planners working for major influential donors often try to earmark local funds, ie. get the local funding for what they see as high priority projects declared immune from budgetary cuts. This, of course, makes the remainder of the discretionary margin even more unpredictable, as the reduced sum now has to accommodate all the fluctuations in national income and expenditure. Finally, managers and administrators contribute to the unpredictability of development funds by failing to control activity and finances well, so that their budgets do not correspond with actual expenditure. They further undermine their credibility by protective over budgeting, and by using the camel's nose technique: if you want to spend money in a particular way that you anticipate will be unpopular, you try to sneak in a small, innocuous-seeming element in one year's budget, and use it to start work. To realise the value of that expenditure (eg on foundations and part construction of a school), further – and larger – expenditure is requested in the following year, on the argument that "we cannot throw away what we've already done".

The consequences of loss of credibility of managers' budgets in the eyes of financial administrators are both specific and general: specific in the sense that, if you want to succeed with pleas for additional funds to cope with unforeseen problems, on your project, people have to be believe that your request are realistic; general in the sense that poor project management makes, in aggregate, a significant contribution to the uncertainty of the budgetary process. An interesting study of this topic suggested that the two parameters that determine the pattern of budgetary behaviour are wealth and variability in the level of income and outgoings. The following classification is based on this idea:

(i) Rich, but uncertain (the oil states at the height of the boom) work by grant budgeting – there is so much money available that any reasonable (and some unreasonable) proposals will be approved; this process occasionally "breaks the bank" and various crisis management measures are then adopted.

(ii) Rich, but certain (developed countries except in times of recession) work by incremental budgeting – the revenue is known, and a relatively tidy version of the budgetary process outlined above is operated with relatively generous and predictable development funding which is not usually subject to revision during the financial year; choice of developments is usually made on an incremental basis.

(iii) Poor but certain (many local government authorities in all parts of the world) work by revenue budgeting, with most of the emphasis placed on making sure that commitments stay within the bounds of anticipated income.

(iv) Poor and uncertain (most developing countries) work by interactive budgeting. Both income and expenditure are highly unstable. In the case of income, this results from economic weakness and reliance on climate-dependent primary products. In the case of expenditure, it results from the relative importance of inherently uncertain development work, aggravated by poor physical and financial management skills. As a consequence, attempts to operate a tidy budgeting scheme fail. Drastic revisions – usually cut-backs – have to be made during the financial year, regardless of their impact on part-completed work. In extreme situations, government delays payment on its purchases, with the results that prices get pushed up and suppliers become unhelpful; in some circumstances, government payment orders are sold at a discount to traders and financiers by suppliers anxious to realise some proceeds to stay in business.

This particular study made the point that the contorted, multi-layered controls on expenditure often found in developing countries are there for reasons other than incompetence and "cultural" love of red tape – and that development and its management do themselves make a contribution to the problem.

Procurement and Managing Materials

Most projects use materials of some sort – fuel and lubricants, spare parts, seeds, fertilisers, stationery. Failure to manage the supply of these well can easily undermine the whole operation: a mechanised farming scheme in a remote area that cannot control its stock of spare parts effectively, or a provincial seed or fertiliser supply corporation that cannot get its main stock-in-trade to farmers when they need it, cannot function properly.

By "manage well" is meant maintaining a sensible balance between the costs of holding too much stock, and the costs of holding too little. The costs of holding too much stock arise in the following ways:

(i) All stock costs money, so that substantial parts of the budget of any operational (as distinct from advisory or administrative) organisation are inevitably tied up in physical materials; the money is not available for other purposes (buying new transport, fixing the office roof), and someone in the system, somewhere, is paying interest on it, even though in most Governmental organisations the charge does not appear in the books.

(ii) The space occupied by the stock itself costs money: extra godowns may have to be hired, as extra space will have to be constructed for the materials needed to back up a given volume of operations.

(iii) Stock shrinks, and the more you hold, the greater the percentage shrinkage. Excess material tends to mean storage for excessive periods, resulting in deterioration (eg granular fertilisers cake; herbicides go past the end of their shelf life; mechanical parts rust). Material does get stolen, and the bigger the store, the less easy it is to control, and the greater the temptation to theft. Cramming a store with excessive material can lead directly to damage (sacks which have been stacked too high burst; items get damaged by forklift trucks trying to work in alley-ways that are too narrow).

(iv) Stocks of some items (particularly some sort of electrical and mechanical stores) may actually need servicing during storage (eg lubricating or coating to prevent rust or corrosion).

The cost of holding too little stock is primarily that of stock outs: someone comes into the store, needing a spare for a tractor, or seeds to be sown this week, and finding that what they need is unavailable. One of the biggest problems here is that materials management is the spiritual home of local sub-optimisation: virtually always the unit controlling the stores is not debited with the cost of stock outs, and there can be a great divergence between the financial performance of the unit (how much it did within its budget) and its economic performance, ie. how much contribution it made to the nation's wealth. An agricultural inputs corporation that does not have seeds and fertilisers when needed may well survive untroubled as a welfare home for its staff, unless farmers are in a position to bring political pressure to bear on it: official budgetary control is unlikely to influence its effectiveness.

Inventory management – maintaining the balance between the two sets of costs – is a question of consistently ordering the right things in the right quantities, at the right time, and getting them to the right place in a cost-effective manner and these will be dealt with in turn in the following sections. Before this, however, it is necessary to note one point: materials management is almost a profession in itself, with its own professional bodies and specialist qualifications, and clearly, an amateur is not going to be able to do such a specialist's job unaided. Equally clearly, many organisations do not have funds to employ them, and the task ends up in the hands of whoever is in charge – that could well be you! The object of this chapter, however, is not to try to make you into an expert: it is to enable you to understand the supplies and materials management function, so that you can work with it effectively; and to give you an awareness of the main issues, so that, if you do have to manage this function without professional support, you can tackle the problem more effectively.

Consistency of procurement

Many purchases are one-off – a piece of equipment, a load of repair materials – that may not be repeated for a considerable time. However, most purchases made by most organisations do get repeated: variations of quantity and timing, specifications may get changed as standards change or new and improved products appear, but there is an underlying continuity which can be a strength, or a weakness.

In the latter case, too cosy a relationship may develop, and the purchasing side of the relationship may well lose out: stores managers find a source of supply, and do not want the bother of looking further. In addition, the supplier begins to see this agency as a captive customer for materials and ceases to make special efforts to respond to urgent requests, or begins to feel that the agency is a suitable place to off-load items that is getting to the end of its shelf life. At worst, staff on both sides milk the system by inflating invoices, ignoring irregularities in amounts delivered, and so on.

At the other extreme, a good procurement manager can generate benefits by recognising that purchasers need suppliers, but suppliers also need purchasers. Continuity of demand should command discounts, and, even more important in some cases, better service. Equally important, major suppliers can be forewarned of long-term purchasing plans, so that the purchaser/supplier relationship could usefully involve not only current contracts and orders, but also information about mid-term intentions of purchases, and discussions of long-term trends in needs. However, it is important to ensure that the last-named two items – information and discussions of future needs – are handled in such a way that no contract or formal order is created unintentionally; you might be obliged to proceed with this, regardless of your true needs.

What constitutes a contract to supply something varies in different countries, and it is useful to be aware of what applies to your local situation. Good procurement practice includes supplier development: if you are not getting the service you want (or if there is only one supplier available, and you are afraid he may disappear from the scene), you should be attempting to find or encourage other suppliers – not so large that you are an unimportant customer, not so small that you place him in the commercially dangerous situation of being a one-product, one-customer firm.

Getting the right things

In many cases, it may seem obvious what "the right things" are: you need fertiliser, seed, building timber, and so on. However, there is room for the people involved in the supplies function to influence what is bought in a variety of ways.

Firstly, some things are easier – and therefore cheaper – to handle than others: looking at the supply system as a whole, it is better to buy imported cheaper granular straight fertiliser in bulk, 20 000 tons per shipload, or slightly more expensive compound fertiliser, ready bagged in paper sacks, but saving the need for bagging and weighing equipment, bulk storage facilities, and so on at the port. Secondly, some things give a very similar performance, but are distinctly cheaper (and often quicker to get) if standard sizes are selected by whoever specifies them: fasteners (nuts and bolts, screws, etc) are a good example – try buying screws of odd numbered gauge sizes, instead of the more popular even numbered gauges and you will see the difficulty – but the same often applies to building timber and constructional steel. Thirdly, products can be over-specified, ie. a higher quality is requested than is needed.

All this do not suggest that ease of materials management should determine what are essentially technical choices; rather, it is to point out that technically comparable choices may have significantly different hidden logistical costs, and there is room for creative interaction between the technical users and specifiers, and the materials management people.

Buying the right quantities

In the case of major seasonal purchases (eg seeds, fertiliser, herbicides) the quantity may be known directly from the plan of action, although where usage is determined by farmer participation in an essentially voluntary scheme, you may be in the embarrassing situation of not knowing whether to go by the plan (and therefore seriously over-order) or rely on some more realistic forecast (and therefore risk being seen as inconsistent, or even hostile to the current policy).

A much more complicated situation arises when it is necessary to deal with a wide variety of different items, in fluctuating demand throughout the year – spare parts for transport and general construction equipment are good examples. Parts arrive in quantity (if you are lucky) at irregular and infrequent intervals: they are issued in smaller lots, also at irregular and usually unpredictable intervals. As a result, the level of stocks of any one item gets topped up to a maximum level, then falls, in a series of erratic steps, until either there is a stock-out or the next batch arrives. In theory, it is possible to adjust the service level, that is the percentage of requests which are met immediately from store, to balance the costs (economic or financial, whichever is more relevant, of. Appendix) of holding stores against the losses resulting from a stock-out; in practice, it is easier to think and work in terms of conventional service levels. Really essential items where a stock-out could be a matter of life or death would get a very high serviced level, say 99.9%; items for which a stock-out is merely an irritation (eg many stationery items) would be assigned a service level of 95% or lower.

These service levels are maintained by setting re-order levels, that is, the amounts of the item at which an order is made. Again, there are sophisticated ways of setting re-order levels, but, basically, to avoid a stock out the re-order level has to be at least equal to the expected usage in the time that will elapse between the storekeeper noticing the item has reached its re-order level and the arrival of new stock (the lead time). If a 95% service level is desired it is the quantity that you are "95% sure" that will be used in the lead time that matters. For a useful introduction to the statistical side of stores management, see Ref 2; given expertise in this area, it is possible to explore the costs of providing various service levels.

Re-order quantities are important – by reversing the definition of re-order level, ROQ is the amount that will be used during the lead time, plus a safety margin (the safety stock). Much work has been done on the EOQ – the economic order quantity – that balances out the costs of acquiring an item of stock with the costs of holding it, but often, in practice in LDCs, the exigencies of the annual financial cycle, the availability of discounts, even the availability of supplies at all dominate over EOQ calculations.

Clearly, before you can work with any of these concepts, you need some system of stores record, to know what you have, what you use, how quickly, and so on. The best of these rely on the A, B, C, system. In any store of reasonably varied items:

- Thirty per cent of the transactions account for 70% or over of the total value; this is the "A" category, which warrants individual control of items, eg diesel injection pumps would be a category A item.
- Seventy per cent of the transactions account for less than 30% of the total value, and cannot justify the cost of detailed monitoring; this is the "C" category, and would include nails, nuts and bolts, lubricants, and so on.
- There is also an intermediate "B" category.

Methods of controlling "A" (and possibly "B") items can be very sophisticated, with individual recording of issue and inventories kept to a minimum. The classic control tool here is a stock control card; these vary in detail, but a common arrangement would be for the card to show:

- What the item is – a verbal description and a code number.
- The maximum level of stocks of the item that should be held.
- The re-order level, ie. the amount of the item at which an order for new stock will be placed (see above).
- In an organisation with several departments, it may be useful to have a note of which departments use it.
- A note of possible suppliers.
- A series of columns to show the amount of the item put into store, the amounts drawn, and the balance; this gives a check on the amount that should be present, and a figure for current stocks for comparison with the re-order level.
- Amounts and dates of orders, so that future stock levels can be forecast if necessary, and overdue orders can be recognised.
- Possibly the price of the item, for use in stocktaking and valuation.

A much simpler card would be appropriate for less valuable items, eg category B items; a card record for this might well consist of only a note of the identity of the product, the re-order level, and a running balance of the quantity that is (or should be) on hand. Both sorts of records yield information for forecasting future usage rates, provided they are used intelligently; for example, parts usage rates will change with increased machine numbers and working hours.

By contrast, less valuable items do not justify complex control systems, because control itself costs money. There are a variety of visual control systems that do not rely on records, for this situation:

(i) A storekeeper runs an impress system, in which a maximum stock level is set, periodical inspections are made, and stocks are topped up either by direct purchasing, or from a central store (eg in the case of local tractor hire depots). In the latter case, control of central stocks would be on the basis of one of the simpler card control systems.

(ii) Either storekeepers, or users (eg mechanics) keep a two-bin system: one bin or other container is in use, the other, full one being kept in reserve: when the first bin empties, an order for new stock is made (obviously bin size has to be related to local re-order level).

(iii) Users have an open access stock of washers, nails, etc which is regularly replenished by a storekeeper.

There is also a visual method for high value single items: a one-for-one system on which items are individually replaced as used, to keep a safe stock level; this is often done for items that are themselves dangerous, or are used in dangerous situations, eg full protective clothing.

Ordering at the right time

In all types of stores systems, the timing of reordering is an issue. The possibilities are:

(i) Fixed level reordering, ie. individual items are reordered when their level falls to the ROL, so that orders for different types of stock pop up at random intervals.

(ii) Fixed cycle reordering, in which reordering of all types of stock is done at fixed dates, in which case the amounts ordered have to take account of the usage likely in the extended time periods involved (the maximum period for which stock has to be provided in the interval between ordering dates plus the lead time, so that average stocks are also higher). Cycle lengths will normally be greater for category C items, of course.

Fixed level re-ordering is most appropriate to category A items; in deciding to use fixed cycle reordering, one has to balance administrative convenience against the additional stock-holding costs involved. Central stores supplying local depots have the converse problem: deciding how to dispatch orders, either in response to individual requests, or to make economical loads.

Orders for seasonally-required materials: One special area, particularly relevant to agriculture and rural development, is the stock control activities of agencies that supply large quantities of bulk materials over a very short period of a peak season: seed and fertiliser supply agencies are the obvious example. Assuming for now that we are interested in a realistic estimate of usage (ie. are not constrained by the need to make orders reflect a fairly arbitrary plan), we have two problems: how much, and when to start ordering.

The first problem is the simpler: if we are dealing with fertiliser, there are two factors involved: the area treated, and the rate of application, which in turn is affected chiefly by prices of fertiliser and anticipated prices of the crop, since these affect farmers' perceptions of the worth-whileness of fertilising a particular type of crop. All of these are, in theory, susceptible to statistical estimation: by carrying out surveys, it should be possible to find out the area fertilised in past seasons, and the rates used, and make a projection. Some apparently simple methods of doing this are in fact, very unreliable; this is particularly true of attempting to put a line by eye through points on a graph. It has been repeatedly demonstrated that there is very poor agreement between different expert observers on where the line should actually go, even to the extent of disagreement about whether the trend is up or down. If at all possible, a proper statistical projection, using the method of multiple regression analysis, should be used to make forecasts; this method extracts a usage prediction equation from a series of records at say sub district level, over a period of years, of fertiliser use (either total or per acre), fertiliser prices and crop prices. Such an equation might look like this:

Average rate of use of urea per acre on rice = 37lb + 0.14 x price of rice in rials per ton 0,03 x price of urea in rials per ton

This implies that, if rice is 100 rials per ton, and urea is 250 rials per ton, the average usage rate would be 37 + (100 x 0.14) – (250 x 0.03) = 43.5 lb per acre; this figure could be combined with estimates of area treated to give a total projected usage. Alternatively, a direct forecast of total usage in terms of the same variable (crop price and fertiliser price) could be attempted. The calculations are, however, extremely tedious, and only feasible with a computer; many planning departments are able now to do this sort of work.

Like all forecasts, the further you go from your data, the less reliable they are: a season ahead they are probably not too bad (apart from the impact of seasonal weather variations, which might lead to delayed planting and a different perceived level of need for fertilisers); 2 or 3 years from the period of collection of the data, the projection is getting rather dubious, and 5 years ahead, well, if you have to make a forecast, this system is probably as good as any, but no forecast is going to be very reliable with that amount of extrapolation.

Unfortunately, the data available for planning fertiliser acquisition are often rather old: eg last year's data may not be available until after this year's crop has actually been sown; and, even worse, the lead time involved in procuring some of these materials are very great. Imported fertiliser presents probably the worst problems. The arrival of a few sacks of fertiliser at someone's farm can be the result of a very long process indeed:

- Transport from local depot by farmer.
- Release from local depot against credit chit from Agricultural Development Bank (itself the end of another chain of activities).
- Delivery by road to local depot.
- Arrival at railhead in District capital town.
- Transhipment, sea to rail at main port.
- Sea freight from manufacturer at major overseas port.
- Placing of order for manufacture.
- Agreeing loan for fertiliser purchase with aid donor.

- Making forecast of needs.

As this whole chain can easily take more than 12 months to complete, fairly obviously the whole process is going to need setting in train a considerable time before the start of the season if shortages are not going to limit uptake. Indeed, in a properly organised system, it is entirely likely that two successive sets of annual orders would be in the pipeline at the same time. The worst possible situation is where the process is set in motion a few months too late, so that an entire year's supply ends up in store for a large part of the subsequent year, locking up funds, and deteriorating. All this inevitably means that forecasts are inevitably being made further into the future than is ideal; and it is, of course, not always possible to meet the forecast needs in full, because of the competition for scarce resources (especially foreign exchange) from other sectors – indeed, negotiations on allocation of funds may set limits to total purchases that make usage planning irrelevant.

Moving materials cost-effectively

There are three main dimensions to cost-effective materials handling: the state in which the material is handled; what it is handled with; and where and how it is stored.

- State of handling: The main options are as follows:

(i) In bulk. Grain in tanker trucks on the railways, shiploads of loose fertiliser are the obvious examples. Bulk transport is, in itself, almost always cheaper per on-mile than in any other state. However, there are limitations that apply even when the quantities required are suitable. Bulk transport vehicles are heavy, and may cause serious damage to roads and bridges; also, it is rare in developing countries for ultimate users to require full lorry loads of grain, fertiliser, etc, so that the bulk has to be broken down at some point into a form more suitable for small-scale deliveries. This will require a depot, to hold stocks, which are required because the rate of delivery to and the rates of withdrawal from the depot will never quite match; at such a depot, there will possibly be needs for bagging, weighing, and stitching equipment, costs of security staff and storekeeper and so on. With a distribution system covering a large area, and with a sizeable mileage of trunk costs of providing these facilities; but if they are not available, or cannot be properly maintained, few things break down as thoroughly as a bulk delivery system whose parts are not all in working order. It is very difficult to set up makeshift arrangements when such a system collapses, and the costs in terms of delay can be enormous: a season missed, or a freighter moored at a dock and incurring huge demurrage charges because of a breakdown in the transport system, are common symptoms of a distribution mismatch in a bulk delivery system.

(ii) Unitised loads: Loads can be packed into medium-sized units in various ways: by stacking bags of feed onto pallets, drums of pesticides into stillages (pallets with mesh or solid sides), putting loose granular fertiliser into "big bags" (usually 1 ton capacity), and so on. Given suitable equipment and access, these are very efficient ways of moving intermediate size loads (a few tons, say) over intermediate distances, eg between a railhead and district depots. However, they are dependent on specialist handling equipment, and if this breaks down, the consequences can be serious; sacks and drums can be handled on a makeshift basis, but big bags of fertiliser, for example, are virtually immobilised by a failure of the handling equipment. Unitised load systems are most valuable when the load size is suitable for delivery to the end user, so that a depot or a transfer stage between two types of transport can be cut out – but this does depend on the degree of concentration of usage, and on the ground conditions and the equipment available at the point of delivery.

(iii) Containers. These are suitable for loads of mixed materials (eg plant components, prefabricated buildings, livestock equipment) over long distances or internationally; they are secure, and often command relatively good freight rates.

(iv) Man-sized loads. The principal version is the sack. This state is most suitable for small quantities, short distances, and sites with poor access – narrow alleys, footpaths, etc; it is very expensive per ton, but is provides for a very robust system. It is least vulnerable to equipment failures, fuel shortages and poorly designed or located stores. What constitute a man-sized load varies, and depends on the packing material; 50 kg is probably a practical maximum, although considerably larger packages (eg bales of jute) are regularly man-handled, though at considerable risk of injury. Certainly bags of the more awkward-to-handle packing materials (eg plastic sacks) should not contain more than this weight; 25 kg sacks, especially for animal feed, are becoming more popular.

Not all materials give you the choice of minimum load size, eg large, heavy spares, such as gearboxes, and you need to be prepared to handle any such items that form part of your stock with proper equipment. Another aspect of load state is the degree of protection needed: material in plastic sacks, metal drums, etc may not need weather protection.

- Equipment: Clearly equipment has to match the state of the material; but it also has to work on the site. If the only available premise for your warehouse is a godown at the end of a steep, narrow alley, then almost all sorts of mobile handling equipment are out; this feeds back into the choice of the state of the load – in this case, man-sized loads are appropriate. There is, in fact, a balance to be struck between warehouse (or other store) location and a whole series of factors:

  ∗ Cost of store.
  ∗ Quality of access (it may pay you to improve this).
  ∗ Available handling equipment and the skills needed to maintain and operate it.
  ∗ The ideal state of the material, as determined by load size and distance travelled.

The main sort of equipment available are: man; mobile conveyors (eg engine power inclined elevators for sacks or bales); fixed conveyors (belts, bucket chains, roller conveyors), which are only really relevant to permanent high-throughput sites storing sacks or bulk; and mobile handlers, eg fork lift trucks for pallets, tractor bucket machines for loose materials. Both the latter are movable between sites, but mostly require a good working surface and reasonable manoeuvring space.

- Warehouse: This has to be right in terms of location, in terms of quality and size, and in terms of internal layout.

  The location of stores and warehouses has been the subject of extensive operations research studies, and interested readers are referred to the works suggested in the notes to this chapter; a solution to the problem of the ideal location of a new network of stores requires specialist knowledge of the available methods and is not a task to be attempted lightly by the non-specialist. However, it is worth nothing that a requirement for storage will arise at each level at which the form of transport and/or the state of the material has to change: the points of transfer from ship to rail, rail to large lorry, large lorry to pick-up will all probably need some form of depot if the “upstream” transport is not to be held up by the “downstream” transport. This is always expensive – desperately so in the case of marine demurrage. There is no point at all in setting up a hierarchy of stores that mimics the geographical hierarchy of the organisation: you do not need district store for seeds, just because you have a district office, for example.

  Warehouses and stores have to be suitable for what they are to store: does the material need weather protection?; What sort of security against theft?; Does the store need to be vermin-proof?; Capable of being fumigated?; Is the material dangerous in any way (eg toxic pesticides, inflammable fuels, solvents)? Stores also have to be big enough – it is not enough to multiply the number of sacks or boxes by their individual size to get space requirements, since a store has to allow space for a receiving and inspection area; for alley-ways and other working spaces and for offices, for the fact that most packages can only be stacked up to a certain height. Very awkward items – large diameter valves, for example – are very difficult to stack, and impossible to stack without special racking and handling equipment; sacks and drums burst if stacked too high; and small spares which are retrieved by hand cannot usefully be kept in racks more than 6 feet high.

  Access has to be suitable – ideally, in at one side and out at the other: a one-door store, especially if overcrowded, tends to build up a sediment of old and spoilt stock at the “dead” end. Stores of some items will need racks or shelves, and, particularly in the case of stores of spare parts, where the number of different items can be very large, some way of tracing them, either by fixed location (Land Rover spark plugs are always in rack number 1137) which uses up more space, or randomly, which uses up less space but requires a sophisticated indexing system. Areas of the store may need to be segregated, for particularly valuable or dangerous goods, for pre-allocated stock, or for defective stock awaiting disposal or return. Some thought has to be given to layout relative to demand, eg do you put all the fast-moving spares near to the issue desk in a spare parts store?

  All these issues are open to sophisticated and expert analysis; the real problem, however, particularly in cases where managers have had to choose premises for themselves, from a list of very poor possibilities, is that often much of the potential benefits available from the best possible solution is actually available to anyone who uses common sense and an awareness of the issues.

The procurement cycle

Procuring any sort of material involves a cycle of steps:

(i) Identifying a need – whether from plans for a new project, or noticing the depleted stocks of a regularly used item.
(ii) Finding a source – using existing sources and vigilantly developing new ones, at acceptable prices.
(iii) Placing an order, and arranging for payment (which can be quite complex, if the material is imported and expensive).
(iv) Progressing – as a bare minimum, checking whether delivery was made at the expected date, but more detailed monitoring may be advisable with complex manufactured items to gain advance warning of delays.
(v) Acceptance – ensuring that the order, any delivery notes or waybills, the invoice, and the actual goods tally with each other, and that the goods are in a usable state, followed by making payments or returning the goods promptly with a statement of defects.
(vi) Storage and issue.

This cycle is often partially neglected, proper acceptance procedures being the site of most of this neglect, although as we will see, neglecting to arrange payment properly is also a potent source of trouble. A related task that is also frequently neglected is the control of surplus or obsolete stock: this takes up space and represents money which is locked up (although often less than the purchase cost of the items would suggest), and it is worth familiarising yourself with your organisation's arrangements for dealing with unwanted stock.

Paying for imported materials

Projects involving substantial amounts of imported materials – including major items of plant – often run into difficulties because of the complexities of actually organising payment for goods between countries. The central problem here is that neither the supplier nor the purchaser wants to part with money or goods until they are sure that the other side is going to fulfil their half of the bargain; payment methods differ in the costs and risks they impose on each party. The main payment methods are:

(i) Payment in advance. This is very convenient for the supplier, and has obvious disadvantages for the purchaser.

(ii) Open account. Rarely used in our context, open account is an arrangement whereby a supplier exports goods to a well-known and trusted customer, and bills him for them just as might happen between trading partners in the same country. This arrangement is appropriate for a long-established purchaser-supplier relationship, where the exchange regulations of the parties' respective governments do not create problems for payment. A variation on open account provides a once-and-for-all guarantee to the supplier for default on payment, it being assumed that such default will end (at least temporarily) the relationship.

(iii) Bills for collection. Under this arrangement, the supplier exports the goods, and sends a set of documents giving title to them, usually via his bankers, to a corresponding bank in the importing country, which then advises the purchaser of the conditions he has to meet before these documents will be released, payment usually being one, of course. With the documents, the importer can now get his goods. There is a danger here that any delay by the corresponding bank or the importer will result in demurrage charges for the goods while in a port godown.

(iv) The commonest single arrangement is the Letter of Credit (LoC). This is an undertaking by a bank to pay the seller a stipulated sum, provided the seller produces certain documents, usually to show that the goods have been shipped in good order. Normally, the buyer asks his bank to open the letter of credit, ie. draft and send it to the advising bank, that is, the bank in the supplier's country which will actually make the payment; the opening bank may be required to ask the advising bank to confirm (ie. itself guarantee payment of) the letter of credit. The outcome of this process would normally be a letter to the supplier from the advising bank, informing him of the credit, stating which documents have to be produced for the credit to be drawn on, and giving the expiry date of the arrangement. Letters of credit may be revocable or irrevocable; in the former case, the buyer or the opening bank can cancel the arrangement, up to the time of shipment – as a result, most suppliers require irrevocable letters of credit. LoCs may also be revolving, ie. the same letter of credit may be made to serve for a number of successive shipments, up to a specified total amount in money. However, it is important to note that, in all cases, the advising bank deals only in documents and has no interest in the goods: the supplier must be able to produce exactly the papers specified, or he will not be paid. Typically, the documents would consist of a set of signed invoices certifying that the goods are in accordance with the contract; appropriate insurance certificates for the shipment; a complete set of clean on board Bills of Lading, endorsed “Freight Paid”. A Bill of Lading is a document that certifies goods, marked in an identifiable way, have been accepted for shipment by identified shippers (ie. normally not a forwarding agent) put on an identified vessel, for carriage by a specified route; “on-board” means that the goods were actually loaded on the vessel, and “clean” means that the shipper has not endorsed the Bills to the effect that the goods appeared damaged. Bills of Lading are normally issued in multiple sets of original, and all must be presented.

Possible variations on this list are: that consular invoices (ie. invoices on special forms provided by the buyer’s consulate) are needed: that certificates of origin for the goods may be required by the buyer or his government to show that, for example, no goods from blacklisted countries are involved; import licenses may also be required (otherwise bye buyer may not be able to clear his goods through customs), as may carnets if the good are to pass through intermediate countries. In appropriate circumstances, air waybills or railway consignment notes may be required in place of Bills of Lading (there are minor legal differences between these different sets of documents). The buyer gets his goods by presenting the Bill of Lading, transmitted via the banks, and everyone is happy – provided that certain problems have been avoided. These are:

(i) The LoC was of the proper type, eg confirmed and irrevocable; failure to get this right may result in the supplier delaying action, and it may also create problems if he is using say an official export insurance scheme, which may well be very pernickety about the degree of protection it requires.

(ii) The documents specified cannot be produced, as might happen if, for example, your (opening) bank specifies consular invoices when your consulate does not provide them; the supplier should look for this sort of problem on receipt of the LoC, but you need to respond to queries from him promptly.

(iii) One or more of the documents is date-expired at the time of shipment/arrival, or import documents were not provided (regardless of whether they are listed in the LoC). No-objection certificates and certificates of origin are commonly the culprits, and it pays you to do all you can to research the requirements for the supplier. Who bears the cost of resulting delays, demurrage, etc, depends on the terms of payment. What the buyer gets for his money depends on the exact terms of the contract – it is important that buyers appreciate the difference between their rights and responsibilities implied by terms such as FOB (free on board), CIF (cost, insurance and freight), etc.

Procurement and project scheduling

The dates at which materials – including items of plant and equipment – are needed at the project can be determined from the schedule.

Human Resources and Personnel Management

The section will cover the areas in human resource management of personnel recruitment, selection, training programmes, and another important aspect of personnel management – employment legislation.

The role of personnel management

Personnel management, according to the Institute of Personnel Management, is the process of management concerned with recruiting and selecting people; training and developing them for their work; ensuring that their payment and conditions of employment are appropriate, where necessary negotiating such terms of employment with trade unions; advising on healthy and appropriate working conditions; the organisation of people at work, and the encouragement of relations between management and work people.

Although many medium and larger-sized companies will have specialist personnel managers in separate departments, the Institute's definition of personnel management above, shows that it should be regarded as another function of general management, like planning and controlling.

The key areas of personnel management are the recruitment and selection of new employees, their training and development, and ensuring that the company complies with all employment legislation. Other areas, such as job enrichment, job enlargement, and motivating employees, have been covered earlier.

Recruitment

A distinction should be made between the recruitment of potential employees and their selection. The aim of recruitment is to ensure that the organisation's demand for manpower is met by attracting potential employees in a cost-effective and timely manner. The selection process is then used to identify, from these potential employees, those individuals who seem most likely to fulfil the requirements of the organisation (both in the short and long term preferably).

- **Recruitment procedures**

  The recruitment procedures of an organisation often embody a particular code of conduct. Thus, for example, an organisation will, wherever possible, advertise posts internally before it advertises externally. When it does advertise externally, it will advertise under the company name, providing details of the vacancy and conditions of employment. It may also seek to inform the candidates of their progress in the recruitment procedure.

  When a company is seeking to fill a post, the first step should be to define and describe the precise nature and duties of the job. This can be very difficult, as the existing formal job description may well not cover all the extra responsibilities and tasks that have built up around the job over the years. Conversely, it may be that the post is no longer necessary for the organisation – those tasks attached to it which do still have to be done could be carried out by other departments more effectively.

  The next stage (providing the organisation still feels that it is necessary to fill the vacancy) is to draw up a description of the skills, demeanour and attributes that an employee would need to do the job effectively. One way is to use a checklist, such as Rodgers' Seven-point-Plan, which sets out a series of headings, under which the manager should list the requirements to do the job. The plan covers:

  1. Physique, manner and bearing.
  2. Attainments - education.
     - experience.
  3. General intelligence.
  4. Special aptitudes.
  5. Interests.
  6. Disposition.
  7. Circumstances.

  This person/job profile can then be used to form the basis of a vacancy advertisement. Consideration should be given to the most suitable and cost-effective ways of advertising for job applicants. Some businesses, eg publishing, journalism and TV/radio, receive and recruit from on-spec applications. Other vacancies are advertised in trade magazines, in local and national newspapers, in job centres, and in university and college careers offices – depending upon the type of job and the type of candidate required.

Selection

Selection follows recruitment. Having located possible applicants and attracted them to the organisation, the company has to select the most appropriate applicants, turn them into candidates and persuade them that it is in their interests to join the company. It must be remembered that, even when there is high unemployment, selection is a two-way process, with the candidates assessing the company just as much as the company assessing them.

Selection techniques

Several techniques are used in the selection process. These include the following:

- **Application forms:** The information contained within an application form or letter received from an applicant constitutes the basis of the selection process. This form provides evidence of the candidate's suitability or unsuitability for a particular post. If the application form reveals that the candidate is suitable, then he/she can be called for an interview. Often an organisation will require an applicant to use a standard application form designed by the company, so as to make him/her address areas of character, competence, experience, etc which the organisation wishes to know about.

- **Interviews**: The interview is the most common selection technique. Conducting an effective interview requires good preparation, so that the interviewer is confident conducting the interview. This will enable him/her to exploit to the full the information already provided by the candidate in the application form, and to maintain control of the interview.

  This last point is important. The interviewer needs to make sure the questions are answered fully, and that the interviewee does not escape with half or unsatisfactory answers. The interviewer needs to cut short responses which go on too long, and also to resist the temptation to get sidetracked by an issue the interviewee has raised – no matter how interesting!

  The interviewer has more chance of maintaining control in the interview if he/she allocates time for dealing with particular areas and sticks to that time schedule. Control is lost if the interviewees succeed in dominating the conversation with their own interests, if they are allowed to spend as much time as they choose over an answer, or if they are allowed to interrupt the interviewer continually.

- **Types of interview questions:** Questioning plays a vital part in a selection interview, as it is the primary means by which information is obtained and the candidate's suitability for the post judged. Questions can either be closed or open ones. Closed questions require a specific yes or no reply, and should be used to check information already provided by the candidate or to change the direction of the interview. Open questions require some reflection or elaboration upon a particular point. These are often used once the interview has been got under way by means of closed questions, and have the objective of getting the candidate to demonstrate his/her knowledge and skills to the interviewer.

- **Numbers of interviewers:** Interviews are usually conducted on a one-to-one basis, but a two-to-one situation is also often used. The latter has the advantage of allowing one interviewer to observe the candidate's reaction while the other interviewer actually asks the questions. A slight disadvantage is that the candidate may be less forthcoming with more than one person present. Another form of interview is the panel interview, in which the candidate is faced with several interviewers. Often candidates are shown round the company, usually either by a fairly recently joined employee or by someone who would be working with the successful recruit. It is in this more relaxed situation that far more can often be learned about the candidates and their suitability for the job than in the selection interview proper.

Psychological tests

Psychological tests are standardised tests designed to provide a relatively objective measure of certain human characteristics, by sampling human behaviour. There are four categories of such tests:

- **Intelligence tests:** These are designed to measure thinking abilities, ie. verbal ability, spatial ability, and numerical ability. Popular tests used by personnel managers for selection purposes usually consists of several different sections, each of which aims to test the candidates in these ability areas.

- **Aptitude tests:** These are tests of innate skills and are devised to obtain information about such skills as mechanical ability, logic and numerical ability, and manual dexterity.

- **Attainment tests:** These measure the candidate's depth of knowledge or grasp of skills which have been learned in the past – usually at school or college. The tests therefore measure such skills as typing standards, spelling ability, and mental arithmetic.

- **Personality tests:** These tests, although sometimes used in the selection process, are of limited value because of problems with their validity.

Psychological tests are not a basic part of the selection process, but they can provide useful additional information about a candidate, supplementing that obtained from application forms and interviews. They are particularly useful where objective information is needed, eg in assessing a candidate's suitability for computer programming training.

Training and development

Personnel management is also concerned with the training needs and the development of all the organisation's employees. Companies which train their workforces tend to have significant competitive advantages over those companies which do not have training programmes, especially when skilled workers are in short supply.

The first requirement of a training program is to establish what the training and development needs of the organisation as a whole (and of individual personnel) are. Only after this has been done can plans be made with regard to the training required to meet those needs. This will include deciding on the objectives, content and methods of training to be used.

Benefits of training programmes

The implementation of a systematic training program has a number of benefits. It provides a pool of skilled manpower for the organisation, it improves the existing skills in the company, it increases the knowledge and experience of employees, and it helps improve job performance and consequently, productivity. Further benefits include an improved service to customers, greater commitment on the part of staff to the organisation, and an increase in value of individual employees' knowledge and skills, together with personal growth opportunities for staff.

The Peter Principle: Continued training throughout a person's career is essential if the Peter Principle is to be avoided. This states that 'in a hierarchy every employee tends to rise to his level of incompetence'. (This applies to all organisations, not just to hierarchies.) The principle works on the basis that organisations want high performance, and so if a person is good at his job, he will be promoted to a better and more demanding one. Eventually he will reach a post which is beyond his abilities, and will be promoted no further, Peter's corollary is that 'in time, every post tends to be occupied by an employee who is incompetent to carry out its duties'. The work of the organisation is done by those who have not yet reached their level of incompetence.

Identification of training needs

A training need arises when there is a shortfall in terms of employee knowledge, understanding, skill and attitudes compared with what is required by the job, or by the demands of organisational change. This can be expressed by Figure 5.13 (GA Cole 1983). Different jobs will demand different things of people. Some will require little knowledge of the work necessary and little skill, but perhaps an aptitude which gives attention to detail. Other jobs will demand specialist knowledge, an understanding of the concepts behind the job, and a high level of specialist skill.

Information for training

Data for analysing training needs can be gained a three levels:

Organisational level: Here data bout the organisation as a whole are gathered, eg its structure, markets, products or services

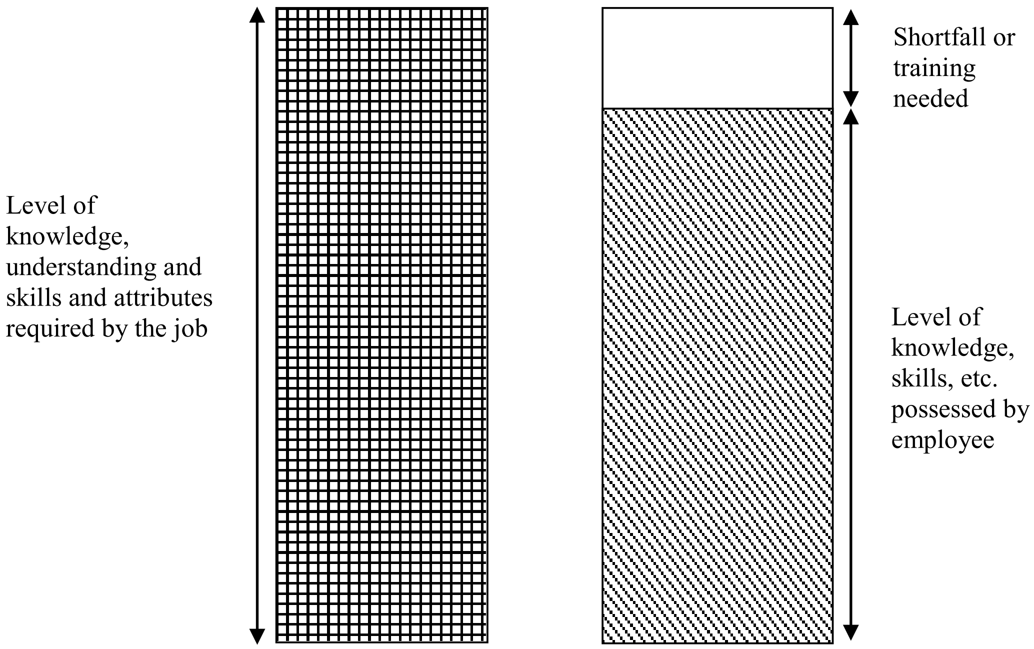
Job level: Data at this level concern jobs and activities, eg job descriptions, personnel specifications, etc.

Individual level: This level of data is concerned with appraisal records, personal training records, test results, etc.

Training programmes

Once training needs have been identified, training priorities can be sorted and initial plans drawn up and costed. These plans can then be submitted for approval to senior management. The key areas for training will be spelt out in these plans, also the numbers and categories of employees concerned, the nature of the training proposed, etc. Training programs can be either formal or informal, and can take place on-the-job or through in-house or day-release courses in local colleges.

Figure 5.13: Identification of training need



Evaluation of training programmes

Evaluation is part of the control process of these training programmes. The aim is to obtain feedback about the results or outputs of the training, and then to use this feedback to assess the value and success of the particular training methods used, with a view to improvement where it seems necessary.

Personnel management and employment legislation

A person employed by an organisation is either employed under a contract of service, as an employee, or under a contract for services, as an independent contractor. It is only the former which is referred to as a contract of employment.

It is important to distinguish whether a person is under a contract of employment or not. If a person is under that contract and is therefore an employee, his/her employer is liable vicariously for any civil wrongs the employee may commit in the course of his/her work; whereas an employer bears no such responsibility in respect of independent contractors. In addition, only employees are granted certain rights, or protection and benefits.

Duties of employers and employees

Both employers and employees have certain duties to one another under common law. Thus the employer is obliged to pay wages, provide work, take reasonable care of the employee, indemnify the employee for any expenses and liabilities, and treat the employee with courtesy. The employee is obliged to render a personal service, take care in the performance of his/her duties, obey reasonable instructions from the employer, act in good faith towards the employer, and not impede his/her employer's business.

Employment protection rights

The personnel manager has to be aware of the legislation protecting the rights of employees, because it is part of his job to make sure such legislation is complied with.

The Employment Protection (Consolidation) Act 1978 gives employees protection over a wide variety of matters, including:

1. Maternity pay and leave.
2. Ante-natal care.
3. Guarantee payment.
4. Time off for a variety of activities, including duties as a Justice of the Peace, trade union duties, and for job-seeking.

The Act also gives every employee the right not to be unfairly dismissed by his/her employer. Two points must be noted here:

(a) The burden of proving that there was a dismissal rests with the employee.
(b) The burden of proving the reasons for the dismissal is on the employer.

Dismissal is defined as including the following:

1. Termination of the contract by the employer with or without notice.
2. Expiry of a fixed-term contract without renewal.
3. Termination of the contract by the employee with or without notice in circumstances such that he/she is entitled to terminate it without notice due to the conduct of the employer.

Dismissal can be deemed to be fair in the following circumstances:

(a) If the employee is proving incapable of, or unqualified in, his work.
(b) Redundancy of the employee, although an employee unfairly selected for redundancy will be regarded as unfairly dismissed.
(c) Misconduct.
(d) Where the employee could not continue in his/her job without causing him/herself or employer to contravene the law.

Part of the Employment Protection (Consolidation) Act provides for industrial tribunals. The jurisdiction of industrial tribunals extends from claims for unfair dismissal, and complaints relating to maternity provisions, to questions of equal opportunity and to unfair discrimination on grounds of race.

Summary

- Personnel management can be regarded as one part of the general processes of management, and as such not exclusively the job of the personnel department and manager. In many small companies there will not be a separate personnel department.

- Many of the duties undertaken by personnel managers also impinge on general management, such as organising people at work, motivating them and encouraging good relations between staff and management, and sometimes training and development (especially on-the-job training and learning by others' example, and through the delegation of responsibility).

- The aim of recruitment is to try to attract potential new employees to apply for jobs advertised by the company. During selection, the company tries to identify those applicants who will meet the organisation's needs, both in the short and in the longer term.

- External applicants are usually selected on the basis of an initial application form and by interviews. Psychological tests are also used sometimes to assess either the level of skills a candidate already has, or inherent skills.

- The company will have far more information about the suitability of internal applicants for posts than for outsiders. In these cases interviews should not be the main basis of judgement.

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POLICY ASPECTS OF PROJECT ANALYSIS

Introduction

The project evaluator always operates within a certain political environment which influences the shadow prices and the choices of distributive weights. Analysts will, however, endeavour to point out all the consequences of a project as objectively as possible. When politicians act contrary to the recommendations of the analyst it must be very clear what price the community is paying for such politically inspired action.

It is not always possible to include all the political consequences in the cost-benefit analysis on a quantified basis, although it is the responsibility of the analyst to point them out in detail on a qualitative basis.

Strategic Considerations

We should begin project appraisal by asking what aspect of market failure is occurring and how the project is going to correct for it. Some projects are occasioned by market failure (see Annexure 1), while others arise as partial corrections for government failure. Project appraisal should not be separated from sector policy analysis. Often, project analysts will develop during project planning a level of sub sector knowledge which exceeds that of others in potential policymaking positions and, thus, will be in the best position to recommend policy changes.

Generally, good policies have more impact than good projects, because policies affect entire sectors. Project analysts cannot estimate accounting prices for project planning until they know whether or not advice on policy reform will be followed. Accounting prices may be calculated in terms of a totally reformed environment –the so-called "first best" situation, or they may be calculated in terms of continued distortions – the so-called "second best" situation. Sectors in which project and sub sector policy decisions tend to be made simultaneously – such as industry – may be best served by some form of "first best" approach; while sectors such as agriculture, where projects represent small additions to the sub sector, might be justified in using a "second best" approach. No matter which approach is used, it may sometimes turn out to be wrong.

This chapter deals with the policy aspects of project analysis. It is important for practitioners and trainers to understand project appraisal in the context of sectoral and macroeconomic policies. Practicing economists should also understand the following policy-related points:

- Project analysts learn things in the process of conducting project analysis that gives them a comparative advantage in arguing for policy reform to increase efficiency in the sub sector in which the project is located, and in some of the backward-linked (ie. input supplying) and the forward-linked (ie output purchasing) sectors.
- Policy reform will often do more to increase national economic efficiency than will one more good project.
- It is important for project analyst to understand the difference between and the implications of "first-best" versus "second best" shadow pricing systems, and the way they relate to the policy environment.
- Projects which are economically viable when appraised using second-best shadow pricing may not be viable under first-best shadow pricing, and may create vested interests against improving the policy environment.
- Project analysts should always ask the following basic policy-related questions before they get deeply into appraising any proposed project:
    - What is the market failure that this government intervention is designed to correct for, or is it rather market distortions due to "unwise" government intervention (government failure – see Annexure 1).
        - Is it market failure?
        - Is it government failure?

- Through what mechanism is this project going to restore optimality and correct for the market failure that the planner has identified?
- Is there a better way to achieve this objective which is less costly, less disruptive, or more specific to the problem as it has been identified?

Required Sub sector Expertise

Project analysts can learn a great deal about a sub sector in the process of doing a project appraisal. If they do their job well, they should be able to recognise the good and bad impacts that government policies have on the sub sector within which their project falls. Project analysts would do their country a disservice if they do not look beyond the project appraisal to ask deeper questions about the policy framework affecting the project.

In the Nigerian example, presented in Box 6.1 project analysts could see that producer incentives were severely distorted by the government's policies on the exchange rate, and that efforts to rationalise trade and exchange rate policies were really the first order of business. As we shall discuss later in this chapter, making project investments in such an environment might not represent the best thing for the country, and it might make it more difficult later to do the things that are best for the country.

Project analysts often know more about the firm-level implications of sub sectoral policies than anyone else in the government. They also know a great deal about the effects of macroeconomic policies on that sector. This is often true, because – in the process of collecting detailed information on the sub sector and of analysing that information – analysts learn a great deal about the financial and economic impacts that government policies have on that sub sector. In fact, it is not unreasonable to argue that – if project analysts are not able to provide such an analysis – they should not be advising society on how to spend its money in the first place.

Good Policies Versus Good Projects

It is an often-stated truism among economists that "a good policy beats a good project any day". What economists mean by this simple statement is that a good policy will affect the whole sub sector, while a project will affect only a part of the sub sector. For example, by pricing rice at an economically efficient level, all farmers will be induced to produce the "right" quantities of rice; however, providing irrigation water below cost to compensate for the distorted price of rice will affect only those farms which receive the subsidised water.

Another reason for good policies being better than good projects relates to what economists call "the specificity rule". What the rule says is that the intervention that is chosen should be directed as specifically to the target problem as is possible. In the rice example, if the problem is that there are poor people who cannot afford as much rice as the government would like them to have, the specificity rule would say that it is more efficient to buy rice and give it to the poor (or simply to give them money) than it is to control the price of rice at a low level and to try to make up for the production disincentive by providing subsidised irrigation water via a project investment.

In strategic planning and government intervention to achieve national planning objectives, policies and projects are the two major forms of intervention. In dealing with a wide range of planning objectives, we find that policies and projects are to some extent substitutable and to some extent complementary to each other. For example, we often find countries with policies which provide for initial subsidies for fertiliser during the period when farmers are learning to use chemical fertilisers. Beyond some learning period, the fertiliser subsidies are to be removed. However, we find that the benefits of fertiliser are also tied to the availability of irrigation as a complementary input. Thus, projects to provide irrigation water may be pursued in combination with policies designed to induce the use of chemical fertilisers (eg initial subsidies on fertiliser use to be removed after the learning period). This fertiliser pricing/irrigation project combination provides an example of a complementary relationship between policies and projects. An example of a substitutable relationship between projects and policies relates to flood control. Flood control projects and floodplain zoning policies may be used in some cases as alternatives which achieves the same objectives of minimising property damage and minimising the loss of life.

Box 6.1: Looking for Policy Implications during Project Appraisal:

The Case of Nigerian Beverage Sweeteners

While appraising a project to produce maize for processing into beverage sweetener in Nigeria, project analysts were able to discover several policy-related issues regarding the maize sweetener sub sector in that country. Three of the issues are mentioned below:

First, the overvalued exchange rate (Nigerian naira 0.80 – US$1) that existed prior to September 1986 made it difficult for Nigeria to produce any tradable good domestically without substantial protection. It introduced several disrupting influences in the economy which led to economically costly "rent-seeking" behaviour by producers, rather than inducing them to focus on production and marketing of products. (For a good discussion of rent-seeking behaviour, see Bhagwati and Srinivasan (1983), pages 317-34, and the references.) Investments were often pursued not for productive purposes, but rather as a means of getting access to scarce and rationed foreign exchange, and to get the foreign exchange at naira prices which substantially undervalued the foreign currency.

The "second tier" auction market, introduced late in 1986, allowed the freed-up market for foreign exchange to raise the rate to more than 3 naira – US$1. At the new exchange rate, tradable goods produced made much more financial and economic sense in Nigeria, and many of the disruptive policies that had been used to maintain the overvalued exchange rate could be removed.

Second, the demand for sweetener production capability in Nigeria was partly caused by import licensing, occasioned by the overvalued exchange rate. This had two disruptive impacts on the Nigerian economy:

- Because of the uncertainty regarding their ability to get import licenses as needed to import raw materials, many firms were investing in local production capacity as an insurance mechanism rather than as an efficient primary source of raw materials; and
- Because of the rationing of foreign exchange, the production plant and equipment for processing maize sweeteners could be acquired at an exchange rate of naira 0.80=US$1 by those who had the political connections required to get an import license. The plant and equipment could be sold later in the local market at a price more closely reflecting the real scarcity of the foreign exchange that was used to import the equipment – ie. at a price more than three times higher. This motivated investors to pursue investments because of the privileged access to the "quasi-rents" on foreign exchange rate than because of the real productivity of the investments.

Third, there are many alternatives to maize-based sweeteners, including sugars made from cane or beets. Many countries subsidise production of those commodities, making CIF prices for imported sweeteners very attractive. It is questionable whether it makes economic sense for Nigeria to use land to produce a product for which numerous inexpensive substitutes exist. The land could be used for other purposes.

We sometimes find that projects are pursued as a means of making up for a bad policy – ie. as a mechanism to correct for government failure. In the agricultural sector, projects often are used as mechanisms for supplying rationed inputs to farmers to make up for output prices that are held at low levels. Or we find projects which are intended to supply potentially tradable products that are in short supply in local markets because of foreign exchange rationing, or other trade restrictions. We also find projects which are intended to supply what are essentially private goods, because the government's policy has destroyed the private suppliers of those goods. In many of these examples, the country would be better served by forgoing the project investment and reforming the policies that are discouraging non-project production.

First-Best Versus Second-Best Shadow Prices

The issue of policies versus projects is at the heart of the longstanding debate over first-best and second-best shadow prices. The debate revolves around several interrelated and sometimes subtle economic issues which have to do with the government's trade and other policies, economists' policy advice, and the way economists derive shadow prices for use in the economic appraisal of projects.

Many developing countries impose trade and exchange-rate barriers that reduce the economic efficiency at which their economies are able to operate. Economists constantly advise governments of developing countries to reform their trade, exchange rate, and other policies in order to reduce these inefficiencies. (See, for example, Zeitz and Valdes (1986).

Whether governments heed the economists' advice is not always clear. **One** factor which makes governments hesitate in heeding to the economists' advice is the number and importance of the citizens who make money off the trade and price distortions at the expense of the country and its other citizens. The longer the distorted policies exist, the greater the number and the richer will be those citizens who benefit at other people'' expense; and the more politically powerful these beneficiaries will become.

The original Little-Mirrlees (Little & Mirrlees, 1969) approach to shadow pricing supported the use of border prices for all project inputs and outputs. Their argument for using border prices was appealing on several grounds. First, they argued that if free trade policies were pursued by the government, all local prices would be determined by border prices. This would occur because all goods and services produced and consumed in the economy use tradable inputs in their production, or substitute for tradable goods in consumption, or both. Thus, trade policies will affect the prices of all goods and services, whether those goods and services are tradable or non-tradable.

Second, the economists' policy advice and their shadow pricing system should be mutually consistent. It made no sense, Little and Mirrlees argued, to advise the pursuit of freer trade while using shadow prices which assumed the continuation of trade barriers. Thus, to be consistent with their policy advice, economists should derive their shadow prices based on an assumption of free trade. That way, when the country's trade barriers were removed, the projects that had been built would be appropriate to the prices that prevailed under the new policies.

The first-best thing for the country to do would be to pursue good policies, including free trade (except, of course, possibly imposing "optimal" tariffs and subsidies in exceptional cases). Shadow prices derived under such conditions are usually referred to as "first best" shadow prices, indicating that they are the opportunity cost which would prevail in the presence of correct policies. Under first-best conditions involving free trade, all opportunity costs could be measured in border prices. (Note that we are including under "free" trade the use of socially optimal taxes and subsidies.)

One point of contention between the authors of the UNIDO Guidelines and those of the OECD Manual was the realism of the first-best shadow pricing approach. The UNIDO authors argued that experience had shown that many countries were not likely to pursue efficient policies during the life of the projects. Thus, by designing projects based on first-best shadow prices, economists would not be designing the optimal set of projects for the environment that was likely to exist.

Analysts should instead derive shadow prices in a way that would assure the best set of projects under the distorted conditions that were expected to exist during the life of the project, argued the UNIDO authors. The first-best thing for a country to do, of course, would be to alter its trade and other policies to make them more efficient; as the country was not likely to do that. So, the second-best thing to do was to build the best projects possible within the distorted environment.

The objective of the shadow pricing exercise was to help the analysts determine which project designs would have the greatest positive impacts on national economic efficiency in the distorted environment that was expected to continue. In other words, the objective was to help analysts find the second-best option. Thus, these shadow prices came to be called "second-best shadow prices".

(i) **Tradable versus Traded Goods:** The essential difference between first-best and second-best shadow prices is that the former views all goods and services as tradable directly or indirectly and, thus, view all inputs and outputs as having opportunity costs which are defined by CIF and FOB prices (international prices). The second-best approach to shadow pricing, in contrast, uses the terms "traded" and "non-traded" rather than the terms "tradable" and "non-tradable" and takes the position that not all economic values can be measured in border price terms due to policy restrictions.

(ii) **Tradable and Non-tradable Goods**: The terms tradable and non-tradable deal with the issue of tradability in principle – ie. taking into account comparative advantage and transport costs only. A good which is non-tradable (in principle) would be subject to the following inequality:

CIF > Local cost > FOB

where:

CIF = cost, insurance, and freight on imported goods; and
FOB = free on board cost of exported goods.

A tradable good, in contrast, would be subject to one of the following mathematical relationships:

Importable good: Local cost > CIF
Exportable good: FOB > Local cost

Textbooks on international trade and payments often define three groups of non-tradables:

(a) Labour;
(b) Land; and
(c) Services.

The above definition, in general, is in line with the textbook definition, except that the non-tradable goods would also include bulky or heavy goods which have a high freight-to-value ratio.

(iii) **Traded and Non-traded Goods**: The terms traded and non-traded take into account not only comparative advantage and transport costs, but also the expected government policies on trade barriers. Thus, a good which is tradable in principle may be non-traded in practice because there is expected to be an import ban on the good during the life of the project. In the second-best shadow pricing system such a good would be treated as non-traded and would be shadow priced accordingly. In the first-best shadow pricing system, the banned import would nevertheless be treated as tradable and would be valued at its CIF price.

Because first-best shadow pricing treats all goods and services as tradable directly or indirectly, it is also consistent with the foreign exchange numeraire. This was one of the factors which led Little and Mirrlees (Little & Mirlees, 1969) to adopt the foreign exchange numeraire. However, the willingness to pay numeraire would be appropriate where substantial trade barriers exist and where many goods and non-traded in practice – whether or not they should have been tradable in principle. Thus, the UNIDO (1972) authors chose a willingness to pay numeraire. Of course, it is possible to use either numeraire in a first-best or a second-best shadow pricing approach. Nevertheless, the foreign exchange numeraire and first-best shadow pricing have remained linked together in the thinking of many economists; the willingness to pay numeraire has had a similar fate with second-best shadow pricing.

After much debate on the realism of first-best shadow pricing, Little and Mirrlees compromised somewhat in the second edition of their book, Project Appraisal and Planning in Developing Countries (1974)[2]. This compromised position was adopted by Squire and van der Tak (1975) and was also reflected in the system of shadow pricing discussed in Gittinger (1982). The decision on whether to treat a questionable good as tradable or as non-traded in the economic analysis has been left open. In fact, this compromised approach puts analysts in a position of having to decide upon which edge of the two-edged sword they will cut.

The two-edged sword of shadow pricing is a subtle one, but it can be very important in some sub sectors. The problem is this: first-best shadow pricing will be a better approach in some cases, while the second-best approach will be more appropriate in others. But it is not always easy to determine ex ante which approach to take.

At the project planning stage, we have a choice of designing a project based on first-best shadow prices (ie border prices) or second-best shadow prices (ie taking into account government policies). Those are two different project designs, in principle. One design will be appropriate in one environment, while the other will be appropriate in the other environment. If we choose the second-best shadow price design, and the government retains its inefficient policies, then we have built the best project for the country under the circumstances that actually exist. But, because the project was "appropriate:" in the distorted environment, we may have also added another vested interest in keeping in place the distorted policies that exist. That is one edge of the sword.

On the other hand, we could use first-best shadow prices in designing the project. We would thus be consistent with the policy advice. And if the government actually heeded the advice, we would have both a good policy and a project that is appropriate within that policy environment. However, if the government continued to pursue distortionist policies, the country would be

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2 (See the February 1972 issue of the Oxford Bulletin of Economics and Statistics, particularly the contributions of Vijay Joshi, pages 3-32, and Partha Dasgupta, pages 33-52. Little and Mirrlees reply to criticisms to their methodology in the same issue.)

worse off with this first-best designed project than it would have been with the alternative project that was designed on the basis of the second-best shadow prices. That is the other edge of the sword.

Both shadow pricing approaches can be wrong in every application. However, the probabilities are greater in some cases than in others. For example, we find that in the industrial sector, policies tend to get formulated at the same time the investment decisions are made. This occurs because of the tendency of industrial sub sectors in developing countries to have only one firm or a few firms, and because of the juxtaposition of scale economies and relatively small domestic markets for industrial products.

Thus, in industrial project appraisal, we usually cannot separate project analysis from sectoral policy analysis. For example, a proposal will be made to invest in a spinning plant to make yarn from imported cotton to substitute for imported yarn. Along with the appraisal of the investment will be a policy decision on whether to ban yarn imports in order to protect the new industry from foreign competitors.

(iv) **First-Best Analysis of Agro-Industrial (added value) Projects**: Because policy decisions and investment decisions tend to go hand in hand in the industrial sector, industrial economists usually argue in favour of using first-best shadow pricing. In other words, they refuse to consider the yarn, in the earlier example, as non--traded for purposes of valuing the output of the spinning project. The first-best shadow pricing approach imposes on industrial projects the requirement that they be competitive with imports in the local market, or that their exports be competitive in other national markets or both.

(v) **Second-Best Analysis of Agricultural Projects**: In the agricultural sector, policies tend to be made separate from investment decisions. This occurs because of the large size of most agricultural sub sectors and because of the minor importance of each new investment decision relative to the size of existing production capacity. In agriculture, it is closer to the truth to assume that the project analyst will be unable to change the policies affecting the project's sub sector. Thus, agricultural project analysts tend to favour using second-best assumptions in deriving the shadow prices to be used in their sector.

The problem with second-best shadow pricing is not so much a theoretical one as it is a behavioural one. If you teach this shadow pricing approach to a practitioner, the shadow pricing assumptions tend to reinforce the line agency staff's existing tendency to act helpless in suggesting policy changes, while arguing for expanded investments into their distorted sector. In other words, the second-best assumptions make it easier for some practitioners to justify accepting many policies that are just plain awful – indeed, may even support their natural tendencies in this direction.

There is a great need to get planners in line agencies to be more active in terms of policy issues rather than being so active in trying to justify additional investments in their sector – channelled, of course, through the good offices of their own agency. A basic problem which stretches the integrity of the agency staff of agricultural and industrial sectors is the impact that distortions can have in justifying additional investments in their sector. (The industrial and agricultural sectors are mentioned because many of the projects in these sectors are occasioned by government failure rather than market failure.)

When we take into account all of these issues, a good case can be made for returning to Little and Mirrlees' original recommendation of complete border pricing – ie. treating everything as tradable directly or indirectly, and border pricing everything. That approach imposes a discipline that will force us to ask why certain projects look so awful when calculated in border prices. Unless we look realistically at economic values, in the way that border pricing forces us to, it is difficult to use the economic analysis effectively to consider policy implications as well.

Policy Analysis and the Theory of Market Failure

Even experienced project analysts have a tendency to forget, in the heat of the project planning experience, that the project represents an alternative "intervention" for helping to restore optimality after some aspect of market failure has occurred. It is useful for us to remember that the model that is being applied in economic efficiency analysis is based on the presumption that some aspect of market failure is occurring and that the government is fulfilling its role of a regulator to undertake intervention to restore optimality to make up for the failure that is manifesting itself elsewhere in the economy.

Scarcity of intervention capacity

There is a very simple reason for addressing the issue of market failure in every project that is to be appraised. The reason has nothing to do with ideology. It has to do with practicality and resource scarcity. Among the scarcest resources in developing countries are those that are required to regulate and to manage. These resources, being scarce, must be used carefully and efficiently. In the public sector, there is often not enough regulatory and management expertise to manage the entire economy.

Thus, in the interests of national economic efficiency, those resources should be applied where they will have the greatest impact and where other management and regulatory resources are not already fulfilling a substantial part of the need. The least need for public sector management is in those sectors where the market works fairly well.

Rationing of intervention capacity

The greatest need for and the highest productivity of public sector management capability, exist in those areas where the market does not work well, or does not work at all. The "theory of market failure" is meant to help us identify exactly where those scarce public sector regulatory and management resources are most needed. In appraising a proposed project, the first act of the economist is to ask: How is the market failing to do the thing that I am asking the government to use its scarce resources to do?

The second question that we should ask should be obvious from the first question: How is the proposed project intervention going to correct for that failure? Again, the intervention should be limited to the failure that has been identified, and it should be as specific to the problem as is feasible.

If we ask these questions every time we begin the appraisal process, we will find that our answers will fall into two groups:

(a) Some project objectives will be related to market failure; and
(b) Some project objectives will be related to government failure.

Recall from our previous discussions that, in principle, projects (like policies) should be designed to correct for distortions introduced by market failure. (Alternatively, we could think of the project as a perturbation in the economy, undertaken to enhance the incomes of targeted groups (see Diewert, 1986). And both forms of government intervention – projects and policies – should, in principle, aim at restoring optimality,. Recall also that we have said previously that projects often result from attempts to correct for distortions introduced by other government policies – ie. from government failure.

Many projects are undertaken not because of some aspects of market failure occurring in that sector, but as additions to or corrections for government failure occurring in that or in other sectors. For this reason, project economists must take a deeper and a broader look at the policy context of the projects they are appraising. It is not sufficient to apply shadow prices to the financial accounts, run an economic rate of return, and write up a report recommending funding. The economist's real value in the project planning process is in reshaping projects to make them more consistent with economic objectives and in looking beyond the project at the policies that shape the sector. Often, the effect of shaping sectoral policies will be much more productive than the effect that the project will have in continuing in a distorted environment.

Accommodating Operational and Political Considerations

In reality operational and political considerations are quite intertwined. The following set of criteria and operational rules is proposed in order to guide further questions and development analysis. Though these criteria have to be attended to in an iterative manner, in practice, the sequence of questions presented below is designed to raise issues in a logical manner. The first eight criteria deal with the macro project issues. These should be appraised early on in a fairly robust manner. The next set of criteria is dealt with at appraisal stage in a more detailed fashion. Obviously the first set of macro questions have to be revisited at the appraised stage as well. The aim of project preparation is to comply as closely as possible with these criteria. In practice, however, it is unlikely that projects will comply perfectly with all the criteria. It is, therefore, up to the decision-makers' to decide on how much deviation is acceptable. The areas and levels of deviation, however, should be clearly noted in the analysis. For operational efficiency, the level of analysis must depend upon the complexity of the intervention and the magnitude of the financial support required. A management decision on the type and level of analyses should be made at project proposal stage.

(i) **Question 1: Is there a FIT between the objectives of the major participants?**

Decision criteria: There must be sufficient fit between the objectives of all participants.

The issue: There are usually three or more major parties involved in projects, ie. the borrower(s), the beneficiaries, and other financiers in some instances. The objectives of each party almost always differ somewhat. In practice, even though objectives can conflict severely, they are sometimes down played at appraisal stage in order to secure project finance. This invariably results in major problems at negotiation or implementation.

Operational rule: Ensure that there is sufficient complementarity between the objectives of major players and that different objectives are identified right up front.

(ii) **Question II: Is there a policy FIT?**

Decision criteria: A project must fit the major financing agency's interpretation of policy as well as the borrower's policy positions and development strategies to be implemented successfully.

The issue: Ideally the financial agency's position should correspond with that of a borrower. This assumption, however, has often proved to be incorrect or problematical. A common point of departure at a macro level has often been distorted when interpreted at a micro level and operational "policy positions" sometimes differ radically from that of a member/borrower, ie. on farming models, user charges, cross subsidisation, etc.

Where a discrepancy in policy occurs, project teams are usually severely hampered in their tasks. It is necessary to attend to the matter of discrepancy right up front, even before a project is accepted into the project pipeline. Failing to do so will invariably result in conflict and time delays during the latter stages of project preparation. The position of non-governmental organisations in this respect also needs to be considered. If there is a discrepancy in the policy position between the agency and such an institution, the same conflict will emerge during the preparation and implementation activities.

Operational rule: It is of the utmost importance to clarify policy positions and determine whether there is sufficient FIT to ensure that a project would be prepared and implemented within an acceptable policy framework.

(iii) **Question III: Is there a program FIT?**

Decision criteria: A project must fit the development program of both the borrower/client and the funding agency's interpretation thereof.

The issue: To ensure the optimisation of linkages and multipliers a project must fit into an integrated development framework. This would eliminate duplication of activities, promote co-operation within and between projects, programs and regions.

Operational rule: The project should aim to optimise linkages and multipliers in the widest context.

(iv) **Question IV: Is there evidence of market or government failure?**

Decision criteria: A project should intervene in the economy only where evidence of market or government failure exists. While it is possible for project interventions to remedy market failures, government failure is generally rectified at policy level (see Decision criterion II).

The issue: Under conditions of so called perfect competition, free markets will automatically lead to efficient economic results. In reality, however, these conditions are often not met and imperfect markets or lack of markets often lead to economically inefficient results. In other circumstances the market outcome may be efficient but viewed as unfair by society. This is particularly the case when the distribution of wealth in society is highly skewed and the good is viewed as a basic need. This is called "market failure". Under these conditions, interventions by the government or public bodies can lead to greater efficiency and equity.

In many cases, however, government policy interventions lead to an even worse outcome because they are non-optimal or government market interventions perform even worse than imperfect markets. This is called "government failure".

Operational rule: "Market failure" or "government failure" should carefully be considered in order to identify whether an institution should intervene at the policy or project level. The project intervention should be aimed at the source of market failure.

(v) **Question V: Which institution is the appropriate source of finance?**

Decision criteria: The major funding institution should be the most appropriate source of development finance.

The issue: While market failure may indicate a need for public sector intervention, the current funding institution might not be the only appropriate public body to participate through financial support. The project analysis should therefore establish whether the current major funding institution is the most appropriate source of finance or whether there are other institutions which could address the identified development need/problem.

Operational rule: A development finance institution is often considered to be a public sector provider of development capital. Government sector, or where appropriate the development initiative itself, on the other hand, should take responsibility for funding of operational/recurrent development costs, eg salaries of extension officers, small business development counsellors, etc. Involvement of the private sector as a partner in a development project should also be encouraged where appropriate. The notion of partnership between the government sector, development finance institutions and private sector should therefore be addressed. A development finance institution should not fund where commercial sources are the most appropriate. Other appropriate public sector capital formation funding sources should also be considered.

Furthermore, appropriate levels of cost recovery from project beneficiaries must be included to ensure better use of the 'market' in resource allocation.

(vi) **Question VI: Who "owns" the project?**

Decision criteria: The beneficiaries should "own' the project. The project must have the support of the target communities/groups/individuals and be rated as a priority by such participants.

The issue: For projects to be sustainable they should have the support of the target communities/individuals or groupings and participants to be affected by it and must address the priority needs. Often, however, projects are imposed in a "top down" manner.

Operational rule: There must be ownership through participation and involvement by beneficiaries throughout the project cycle. In other words, community participation is of paramount importance.

(vii) **Question VII: Who gets the benefits and who incurs the costs?**

Decision criteria: Benefits of a project intervention must be predominantly received by the target communities/groups/individuals.

The issue: Often secondary players reap the major benefits of a project. Sometimes unintended communities incur substantial costs.

Operational rule: It is essential to ensure that the target community/group/individuals indeed receive the predominant share of project benefits and that communities incurring unintended costs are adequately compensated. The indirect income and cost effects of the project should also be considered in this light.

(viii) **Question VIII: Is the project financially affordable?**

Decision criteria: All project participants must have sufficient financial capacity to sustain implementation and maintenance of the project. This includes both the borrower and the project participants, be they producers or consumers.

The issue: The costs in fiscal and monetary terms might be of such a magnitude that revenues will not sufficiently offset costs on a "cash flow" basis, such a project must be judged as unaffordable. This should be assessed from each participant's point of view.

Operational rule: There must be budgetary provision. If not, should it be at the cost of another project? Project participant, borrowers, or farmers/small business should be in a position to sustain the operation and maintenance of the project.

(ix) **Question IX: Do economic benefits exceed economic costs?**

Decision criteria: The project must contribute to economic growth.

The issue: In order to achieve sustainable economic growth the social benefits, tangible and intangible, to be derived from the project must exceed social costs, tangible and intangible. The problem of measurement is important as not all benefits and costs are quantifiable. This issue should therefore finally be resolved through informed judgement. Various techniques, however, can be employed to support a well-informed decision-making process. One of these techniques is cost benefit analysis.

Operational rule: Describe all benefits and costs, quantitative and qualitative as clearly as possible, including direct and secondary benefits and costs; quantify as far as possible; use judgement based on insight and knowledge of the development process to reach a final decision.

(x) **Question X: Are the project benefits sustainable?**

Decision criteria: A project intervention must result in sustainable and equitable development.

The issue: In order for projected benefits to materialise over time a project must generate sustainable processes. This means that the project must be financially, technically, institutionally, environmentally, socially and politically sustainable. The benefits must be perceived to be distributed in a fair and just manner to ensure that equity considerations are met and the implementation of the project can be sustained through participation. Project analysts should therefore consider all these facets to determine the sustainability of a project.

Operational rule: All factors that could result in project failure should be adequately considered and addressed. Project risks should be clearly stated.

(xi) **Question XI: Is it the "best" alternative?**

Decision criteria: The project must be seen to be the optimal solution to the identified set of problems and objectives.

The issue: While the above criteria are necessary conditions for financial support, it is possible to optimise by considering different options to addressing the problem. These options (or alternatives) are often referred to as models and are "built up" through alternatives in technical and institutional design. Such alternative arrangements usually result in differing economic and financial outcomes. The benefits and costs attached to these alternative models should be compared to determine the optimal solution.

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PART II STRATEGIC PLANNING AND PRIORITY SETTING IN RESEARCH AND DEVELOPMENT PROJECTS

In the development literature much has been written about project planning largely referring to development oriented projects with either little or no emphasis on agricultural research projects. It is an established fact that at least in many agrarian economies of the developing world including several countries in Eastern and Southern Africa, agriculture does play a fundamental role as an engine of economic growth. Many studies (Lipton and Longhurst 1989; Hazell and Ramsamy, 1991) have shown that technology driven agricultural growth can contribute significantly to growth in national income and can reduce poverty. The only feasible solution to many countries' agricultural growth and related economic development issues is through continuous technological process which can only come through sustained investment in agriculture and knowledge related activities. The demand for agricultural research services has been growing over the last decade, at the same time the core of public research budget have declined (in real terms) in many countries. Despite the structural adjustment, the public sector in most ESA countries will continue to make huge investments in agricultural R&D. As a result of the declining funding, and emerging alternative funding mechanisms to support agricultural research, the issue of planning and priority setting has become much more relevant today than ever before.

Most of the graduates from the agricultural universities end up within the research and extension services and a number of them eventually become research managers. Though the major principles and concepts are the same, due to its peculiar nature, research planning in agriculture requires some special consideration. Planning for agricultural research must take place in the context of national development planning if it is to have its full impact on development. This means that the planning process must take into account the national goals and priorities. The various aspects of research planning are discussed in chapter 7.

Research planning is a much broader concept, covering not only project and program planning but also planning for the development of resources (human, physical and financial), research policy making, and the identification of organisational structure for the national system. Thus this section deals with individual project and program planning as well as the strategic planning process. Methods and tools that are used to facilitate the research priority setting process are outlined in chapter 8. The strategic planning process and the various components of a strategic plan are discussed in chapters 9 and 10. Another emerging concept in the complex and rapidly changing environment is scenario planning which is discussed in chapter 11. When dealing with research one has to recognise that there are three broader categories of research - namely basic research, strategic research and applied/adaptive research. Most of the concepts and principles discussed in this section are relevant to strategic and applied research planning processes

RESEARCH PLANNING

Introduction

In the light of the declining funding support for agriculture R&D activities, in many countries research planning and priority setting has become much more important than ever before. Planning occurs at all levels i.e. at each decision making level. The concepts of planning, program planning and project planning are discussed in this chapter. Steps in planning both socio-economic and bio-physical types of projects are outlined.

Planning

Planning allows people to organise resources and activities to achieve previously defined objectives and stay in tune with the needs and demands of the environment. The modern vision of planning is a mix of philosophical, technical, social, economic and political concepts. Although there are many different definitions of planning, most include several of these six features:

- Rationality in the selection of options;
- Coherence in the formulation of objectives;
- Congruence among objectives, resources and policies;
- Strategies for reaching the objectives;
- Outline of the preferred future; and
- Elements of the political viability of the plan

Agricultural research institutions in general prefer to adopt a planning philosophy with the following characteristics: (ISNAR, 1995).

- flexibility to allow innovation and adaptation;
- being in tune with environment;
- long-term commitment;
- participation of institution's human resources;
- multiple approaches;
- decentralisation of process;
- consistency with the prevailing management model; and
- congruence and integration of planning activities with monitoring and evaluation. A generalised definition of agricultural planning is given in Box 7.1.

Box 7.1: Agricultural Research Planning

In the case of agricultural research, planning is understood as a process to rationally combine organisational resources, to allow an institution, centre, program or project to achieve certain objectives in a specific context or environment.

Levels of Planning

Planning, in the broadest sense of the word, occurs at all level. Every institution has three basic decision-making levels:

(a) Top management – the strategic level;
(b) Middle management – the tactical level; and
(c) The operational level.

Table 7.1 shows these three levels and the associated type of planning and their characteristics.

Table 7.1: Decision-Making Levels and Types of Planning

Decision-making level	Type of planning	Characteristics
Top management • Strategic level • Strategic decisions	**Strategic planning**	• Diagnostic and prognostic process that considers the institution as a whole, as an open system, and in relation to its environment; • Long-term objectives, goals, policies, priorities, and strategies (10-15 years), which indicate the tactical planning; and • More comprehensive, with greater risks and less flexibility than tactical and operational planning.
Middle management • Tactical level • Tactical decisions	**Tactical planning**	• Organisational process that considers the subsystems of the institute; • Medium-term objectives, goals, policies, priorities, and strategies (3-5 years), derived from the strategic plan, and oriented to the operational planning; and • More comprehensive, with greater risks and less flexibility than operational planning.
Operations • Operational level • Operational decisions	**Operational planning**	• Practical process, that considers the individual activities of each subsystem of the institution; • Short-term objectives, goals, policies, priorities, and strategies (1 year), derived from the tactical plan, to be implemented; and • Not as comprehensive, less risks and greater flexibility than strategic and tactical planning.

Source: Adopted from ISNAR (1995)

Within the National Agricultural Research Systems (NARS) of ESA countries planning occurs at the following levels:

- *Systems level.* The ‘system’ refers to all organisations that carry out research in a country.
- *Institutional level.* The ‘institution’ is an agricultural research entity.
- *Program level.* The ‘program’ is a set of projects and activities of agricultural research, made up of sub-programs, projects and activities oriented to the achievement of program’s objectives.
- *Centre level.* The ‘centre’ corresponds to a regional entity or to an experimental station, which is part of an agricultural research institution.
- *Project level.* The ‘project’ is a set of interrelated activities with a common purpose.
- *Activity level.* The ‘activity’ is the basic research unit, an experiment or a training workshop is an example.
- *Researcher level.* The ‘researcher’ is the individual responsible for research activities. Very often a multidisciplinary team approach is encouraged.

For our discussion purposes we could identify three types of planning: the strategic planning, the program planning and the project planning. The strategic planning process is discussed in detail in the next chapter. This chapter focuses only on program planning and project planning.

Program Planning

The term “program” designates not only the group of activities, but also the organisational entity performing them. When several institutions are involved, the researchers form what is known as a network. Program planning covers the formulation of research program, i.e. the content of research. A research program consists of a set of components that are called research projects. Each project comprises of activities (experiments or studies) that lasts only until results are obtained. The program itself has long-term perspective i.e. program planning is long-term in nature. A program may have sub-programs as in the case of programs involving several commodities (grain legume program, cereals program) or production system (e.g. coffee-banana systems). Within a program, there may be three different types of planning that can occur:

- Identifying priority research topics;
- Development of project proposal covering the identified topic;

- Annual program planning; where researchers meet to review the past year's results and plan the next year's activities adjusting them where necessary and specifying the budget required.

These three program planning levels do not necessarily follow a logical or required order but may co-exist or overlap. It is important to keep in mind the term research program refers to a coherent grouping of research activities all relating to specific field. This could be a commodity (e.g. rice program or beef program) or a group of commodities (e.g. cereals, small grains), an agro-ecological zone (e.g. semi-arid or highland program) or a production system or a production factor.

There are eight steps involved in research program planning: sub-sector review, constraint analysis, evaluation of existing research results, determination of research objectives and strategy, identification of research projects, priority setting, human-resource gap analysis, and recommendations for implementation (Collion & Kissi, 1995). These steps are discussed briefly in the following sections.

Sub-sector review.

This step investigates the status of the commodity, production system/factor or specific topic addressed by the program and analyses its development objectives. During this process, information and data related to the country's economy and development objectives, agro-ecological zone, producers and the production system are collected. List of data collected include:

Economy and development objectives:

- National development objectives;
- Area under cultivation, quantities produced, prices together with trends;
- Estimate of future demand due to growth in population and income, supply and demand elasticities;
- Target groups; and
- Trends in imports, exports, potential for earning income and foreign exchange

Agro-ecological zones and producers:

- Agro-ecological characteristics - climate, soil and topography;
- The contribution of each zone/system to national production;
- National development objectives for the zone/production system;
- Socio-economic characteristics of the producers; and
- Farmers' production objectives.

This information serves as the basis for determining the yield increase that can be achieved and sustained for each agro-ecological zone.

Constraint analysis

This step analyses the constraints that prevent the realisation of development objectives and potential. This enables the development of a constraint tree or the causal-effect diagram. Constraint analysis should be done by agro-ecological zones and if need be, by production system. Constraints are largely a function of agro-ecological and socio-economic characteristics. Constraints may be technical, socio-economic and/or institutional. Information on socio-economic and institutional constraint is used to select the technologies to be developed as well as to formulate recommendations to policy makers.

The constraint analysis also allows participants to address the feasibility of the development objectives.

Evaluation of existing research results

The aim here is to assess what research (both within the country and elsewhere) has achieved so far in addressing the constraints identified. An analysis of this kind enables one to identify those areas that need further research. Research should be continued only if it has produced partial but promising results, or if its results remain to be tested or validated on-farm or in other national agro-ecological zones.

The analysis also enables unproductive research to be identified, so that decisions can be made as to whether it should be discontinued or given another chance.

Determination of research objectives and strategy

This is an important step in the process, allowing the first pass at defining the new program. The information developed through constraint analysis and evaluation of existing results will enable one to identify the research opportunities. The constraint tree should be converted into an objective tree. A given constraint can be tackled through several different lines of research. The objective tree will display these lines so that a strategy can be formulated - the term strategy means a set of research activities designed to overcome a given constraint.

Identification of research projects

These are identified together with their objectives, major activities, locations and the human resources required. This is a set of activities accompanied by a schedule for achieving results. The combined results of the activities should enable the constraints to be overcome. For example one of the critical constraints identified is the pest. This constraint could be addressed by several means either singly or in combination. The various options may be improved understanding of the incidence, resistant variety, chemical control, biological control, control through cultural practices, or integrated pest management.

Priority setting

This step first identifies the criteria and method to be used, then applies them to define a priority set of projects. Priority setting is based on perceived contributions of each project to national development objectives. The reported methods for priority setting include simple checklist, weighted method (scoring), index number approach, econometric approach, simulation techniques and mathematical programming. (For detailed discussion of these methods see chapter 8). There is no right or wrong method for priority setting. The choice depends primarily on the flexibility of the method, given its requirements (data and technical capability) and the institutional and national context. Whatever method is used, what matters most is that the method should help to build consensus regarding future priorities. This will allow an initial priority ranking.

The critical step is the next one, which is to use the ranking to select a group of projects that must be implemented before all others. The number of projects in the set will depend on the number of researchers available to the program and the critical mass of resources considered necessary to achieve impact.

Human resource gap analysis

Here the difference between existing human resources and those necessary for implementing priority projects are examined. Based on the analysis a table can be formulated to facilitate discussion (see Table 7.2).

Table 7.2: Results of Human Resource Gap Analysis

Discipline	Need/ requirement	Availability	Gap

The number of researchers needed, their disciplines, and the number of research years required, have been listed for each project. The difference between this and the number currently available is the human-resource gap.

Recommendation and implementation

This step spells out what must be done to make the new program operational. It also provides guidelines to policy makers on any measures needed to ensure the adoption of research results. The objectives of this step are:

- To present decision makers with an outline of the measures that need to be taken to ensure that the program priority projects can be implemented and that research results are adopted; and
- To prepare for program implementation including monitoring and evaluation (M&E) of the program.

The constraint analysis provides the basic information for recommendation on socio-economic and institutional issues.

It is important to make sure that the program includes both bio-physical and socio-economic types of research.

Project Planning

The themes for projects can be derived from various sources. At present various participatory methods are being used to identify project ideas. Within the emerging participatory approaches (rapid rural appraisal, participatory rural appraisal, participatory learning and action, participatory action planning, etc.) one can identify three main types of tools that are used in the planning process – (used separately or in combination): tools for ranking the relative importance of production problems; for examining the causality of problem, and for screening potential solution. The various steps of the farming systems approach to technology development and transfer are summarised in Figure 7.1.

Various diagnostic tools (field observation, informal interview, group interview, key informant survey, focus group discussions) are used to identify the farm level constraints/problems. Various ranking techniques are used to identify on priority problems. These include preference ranking, pairwise ranking and matrix ranking. The various ranking techniques are discussed elsewhere (Chapter 8) in this sourcebook. If matrix ranking is used, the main challenge is to choose sufficient and suitable criteria and decide how to weigh them.

Flow diagram or a problem tree is the common tool used for examining the causality of problem. See Figure 7.2 and Figure 7.3 for causal effect relationships of two priority problems identified during diagnostic surveys in the region. The solution or research opportunities chosen, depends on the correct identification of causes.

The planning process and various steps involved in the planning process are summarised in Figure 7.4 and Figure 7.5. The diagnostic stage directly feeds into the planning process.

Step 1: Identify and list the problems which limit the productivity of the farming system and the evidence for their existence. This information is directly derived from the diagnostic set of activities.

Step 2: Rank problems with respect to their distribution (who suffers from them); importance of the enterprise; and severity (on average for those who suffer). Once again various ranking techniques could be used and the commonly used technique by the farmers is pair-wise ranking.

Step 3: Identify the causes of each problem and construct a flow diagram for each one (see sample shown in Figure 7.2 and Figure 7.3).

Step 4: Identify leverage points or special research opportunities by examining the flow diagrams. This is often done by examining and or combining the various problem - cause diagrams, to see if they have points in common.

Step 5: Identify possible potential/solutions to the priority research problems diagnosed. These may result directly from the causes or possibly through the systems interactions identified. This is often achieved through brainstorming sessions followed by focus group discussions with farmers.

Step 6: Evaluate the possible/potential solution in order to identify feasible solutions. The common criteria used is screening feasible solution include:

- technical feasibility - probability that the technology to be tested will function;
- economic viability - ensuring that the anticipated returns are greater than the cost;
- compatibility with the farming systems – make sure that they are in line with the objective, preference or resource use pattern of the farmers;
- contribution to reducing risk
- need for institutional support;
- ease of testing by farmers;
- ease of experimentation; and
- ease of adoption

The first three criteria are considered to be critical. The next two criteria are desirable characteristics of a solution but not essential. The final three are usually only used when it is necessary to choose between solutions that otherwise have been rated similarly. A scoring model could be used to evaluate the alternatives. See Box 7.2 for a sample scoring sheet.

Figure 7.1: Stages in Farming Systems Approach to TDT

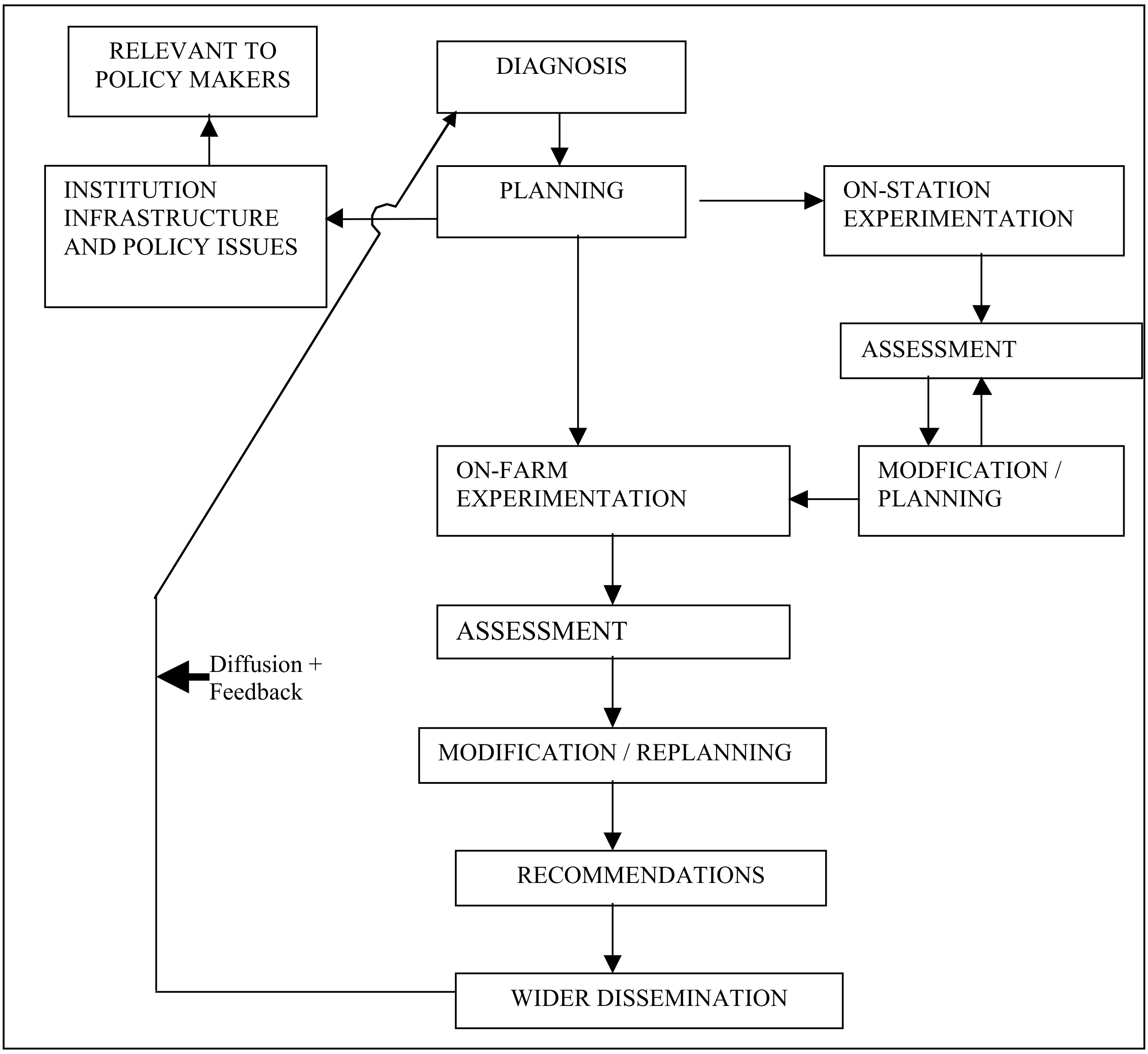


Figure 7.2: Cause Effect Flow Diagram – Inadequate Feed for Cattle (Kenya)

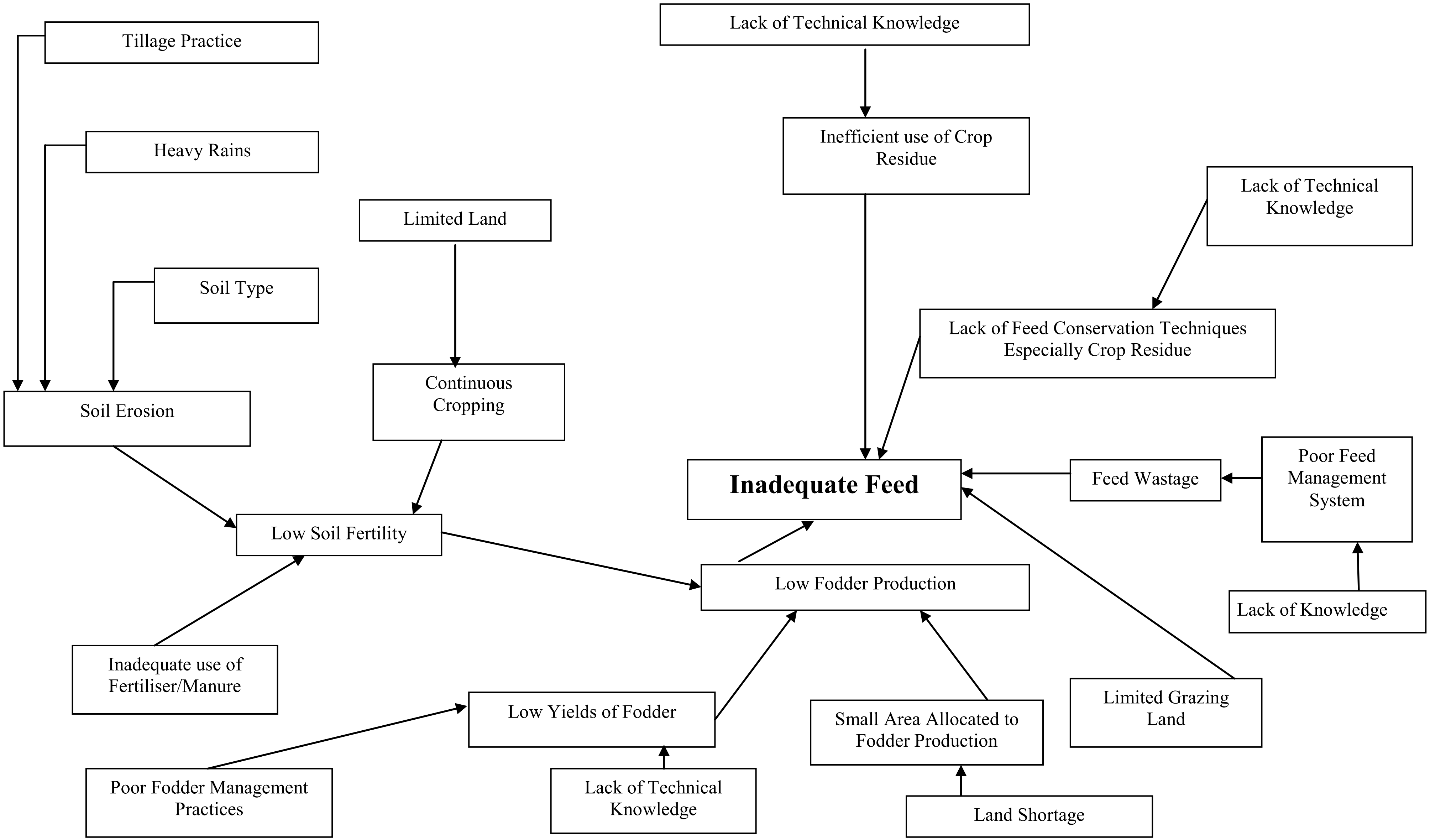


Figure 7.3: Cause Effect Diagram – 'N' Deficiency in Maize

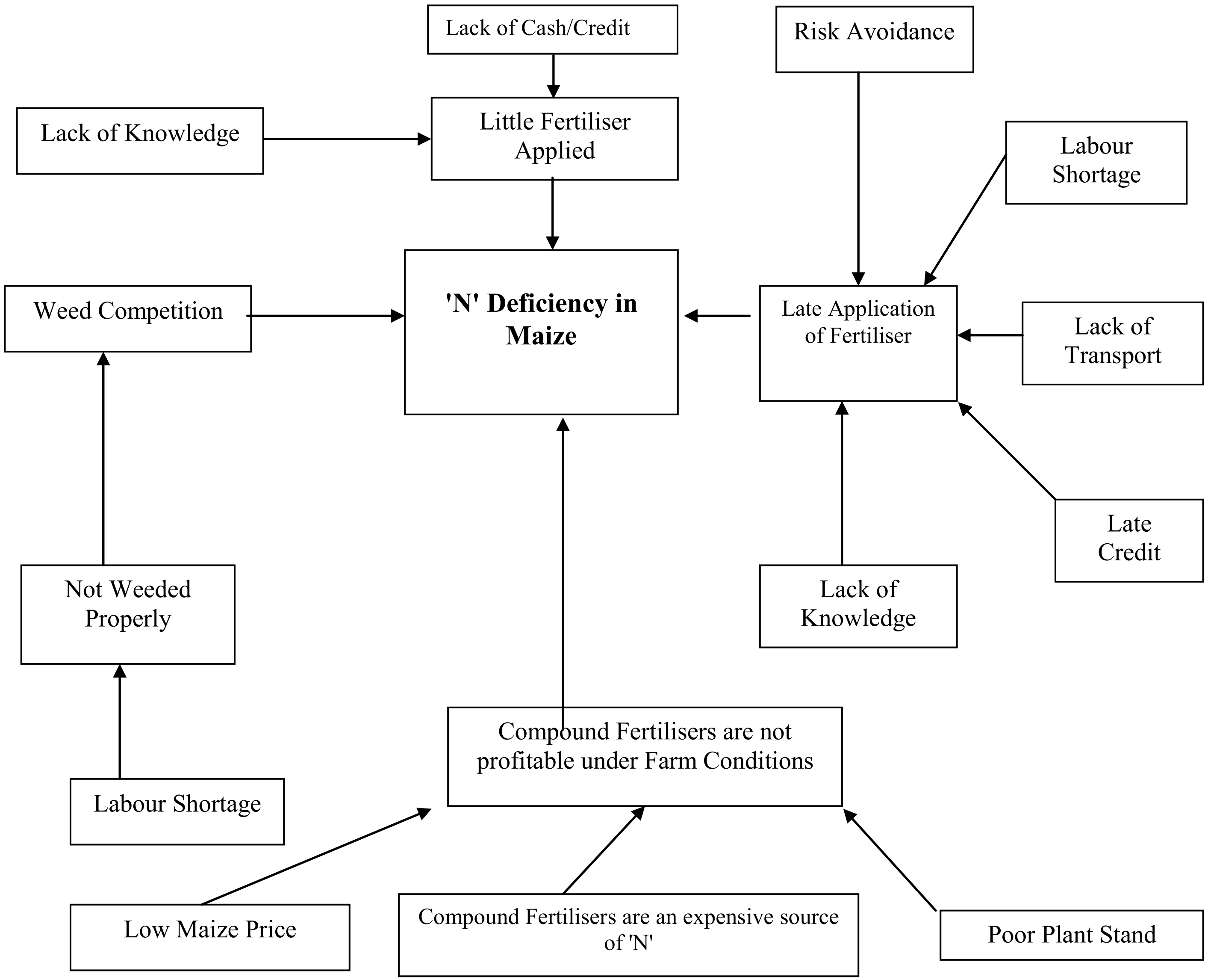
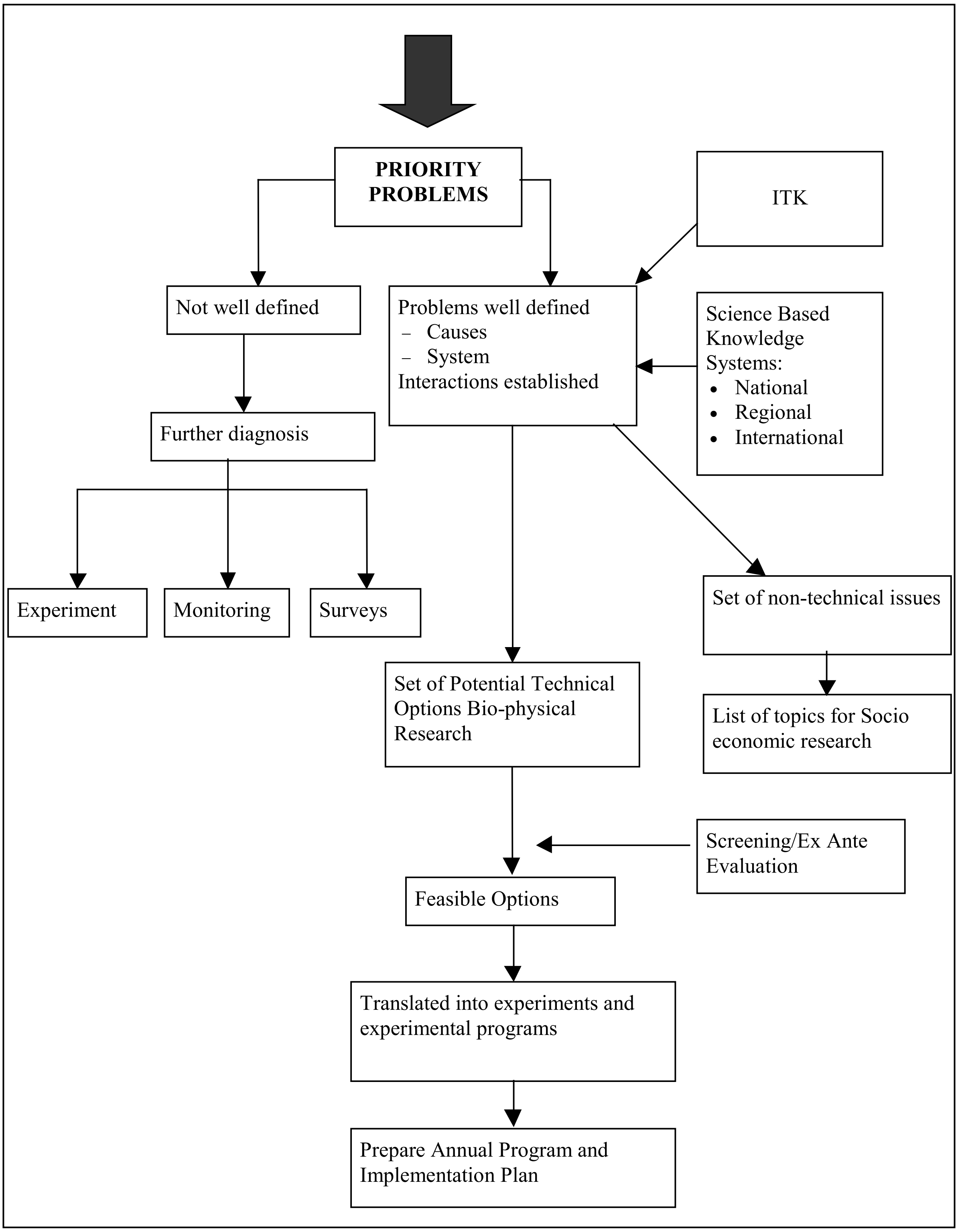
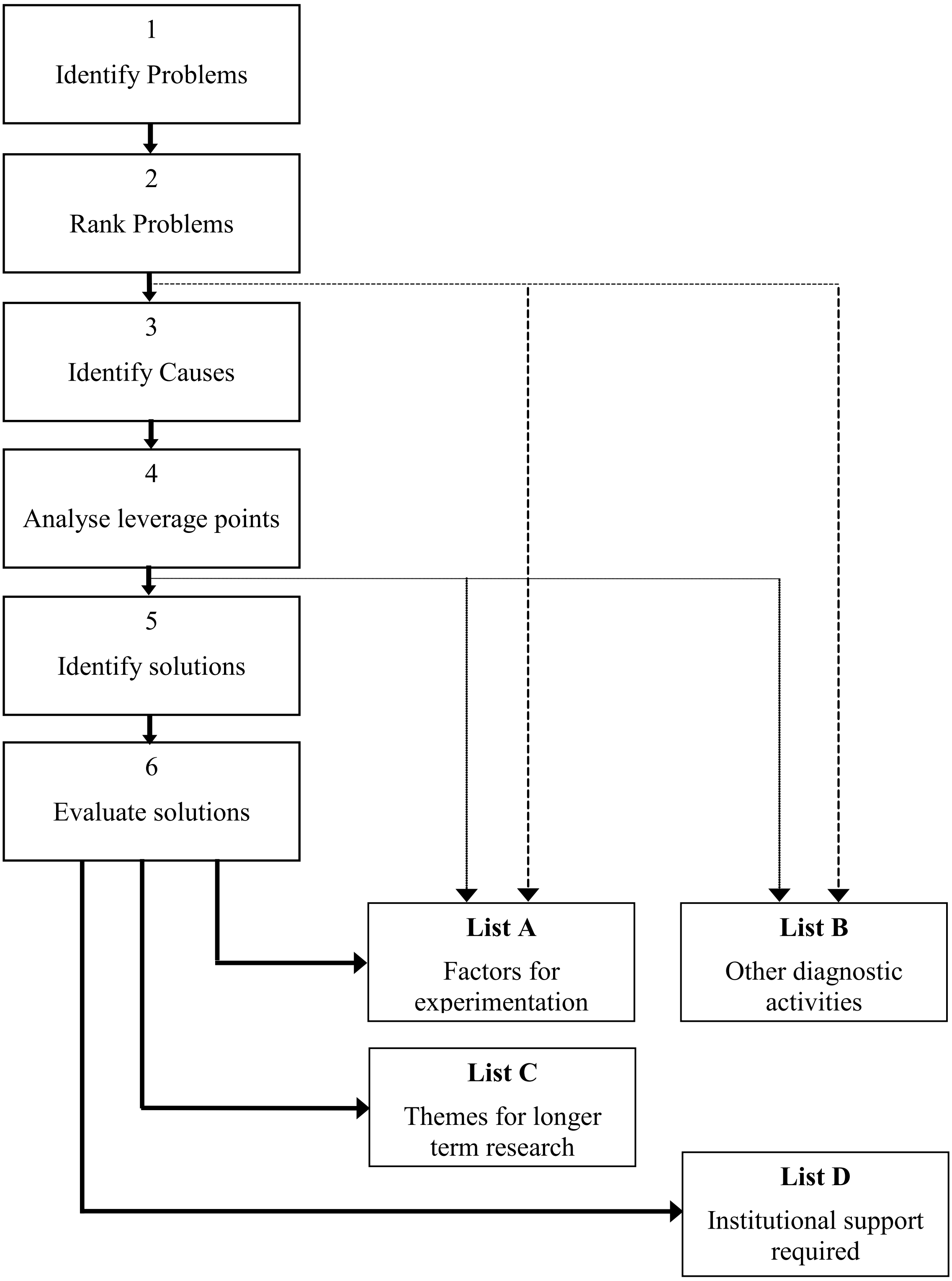


Figure 7.4: The Planning Process



SOURCE: Anandajayasekeram, 1996

Figure 7.5: Steps in the Planning Process



Adapted from Tripp and Woolley, 1989

Box 7.2: Scoring Model for Screening Potential Solution

Criteria	Option A	Option B	Option C	Total Score
Technical Feasibility Expected Profitability Expected Risk Relative Research Cost Divisibility Complexity Sustainability System Compatibility Time lag/Gestation Period				

Key for Scoring

XX = Favourable
X = Somewhat favourable
O = Unfavourable

Remember that the key used for scoring (XX, X, O) do not have any explicit weight but only facilitate making judgement, i.e. , ordinal rather than cardinal.

This step in the process may result in four sets of activities;

- Factors for experimentation (mostly on-farm);
- Themes for long-term research (priorities for on-station research);
- Other diagnostic activities; and
- Institutional support/socio-economic and policy oriented studies.

Step 7: Prepare outline of trials/experiments and diagnostic/socio-economic studies and estimate the resources (human and operational) required for each.

Step 8: Trial and diagnostic study outlines are adjusted to fit the resources available.

Step 9: For each activity that passes Step 8, details are worked out. A typical outline of a trial should include definition of the problem, statement of objectives, choice of experimental design, choice of treatments, determining the number of replicates, choice of experimental material, choice of experimental unit, selection of farmers, selection of site, arrangement with farmers, data collection (including method, frequency and identified person) and data analysis including details of monitoring and evaluation. Socio-economic type of research may involve case studies or surveys. In planning the socio-economic type of studies the following details should be spelled out: definition of the problem, statement of objectives, definition of the population and sampling unit, types of survey, details of the survey instrument, logistics, as well as methods of data analysis. The entire process is participatory, and the relevant stakeholders (farmers, researchers, extension staff, NGOs, etc.) are expected to participate in the entire sequence.

Planning Socio-Economic Types of Projects

As mentioned earlier participatory diagnosis will often lead to some intervention. The interventions fall into three categories: research, extension and policy intervention. This means the diagnosis will result in both bio-physical and socio-economic research. The bio-physical intervention results in experiments and the socio-economic type of research often results in some forms of surveys or case studies. In this section various aspects of the design and conduct of surveys are presented.

Steps in the conduct of surveys

As in the case of experiments, the design and conduct of surveys involve a number of steps. The key steps include the following: (i) definition of the problem, (ii) statement of objectives, (iii) definition of the population sampling unit, sampling method sample size (iv) deciding the type of survey to carryout (v) conducting the survey; and (vi) analysis of data.

These steps, except data analysis, are briefly discussed below.

(i) *Definition of the problem*

The problem to be investigated should be clearly stated to facilitate the formulation of questions which when answered, will lead to solutions.

(ii) Statement of objectives

The objectives of the survey should be stated as concisely as possible, each objective being stated as a hypothesis to be tested, parameters to be estimated, or a decision to be made. When there are several objectives, they should be stated in order of importance as this might have a bearing on the sampling design and the data to be collected.

iii) *Definition of the population and sampling unit*

The population of interest must be clearly defined. For sampling purposes, the population must be divided into distinct sampling units which together constitute the population. The units may be natural units of the material, such as individuals in a human population, or natural aggregates of such units, such as households, or they may be artificial units, such as rectangular plots in a farmer's field, bearing no relation to the natural subdivisions of the material.

It is not always necessary to make an actual subdivision of the whole of the material before selection of the sample, provided the sampling units can be clearly and unambiguously defined.

(iii) *Deciding the type of survey to conduct*

One can conduct an informal or formal survey, or both depending on the type of data required. In both types of survey it is important to choose appropriate methods and/or sampling designs to be used. In the case of informal survey, no sampling procedure is used but screening questions are asked to ensure that the individual farmer belongs to the target group being studied. For formal surveys it is important to choose an appropriate sampling design. Commonly used sampling designs will be discussed briefly in the next section.

(iv) *Conducting the Survey*

For successful conduct of a survey, the following have to be done:

- Choice of farmers and establishing working relationship with them;
- Selection of professional and field staff to conduct the survey and training them;
- Preparation of a checklist, in the case of an informal survey, or a questionnaire, in the case of a formal survey; and
- Acquiring the necessary facilities (vehicles, equipment, etc) required for the survey.
- Carefully planning the logistics to complete the survey.

Some of the issues that need to be addressed in conducting a formal/verification survey are discussed in the following sections.

Sampling

Why Sample?

A survey can be defined as a fact-finding mission. In a typical survey, the researcher selects a sample of respondents and administers a standardised questionnaire to them.

In an attempt to draw inferences about a population (target group), we normally encounter one big problem. A population is the theoretically specified aggregation of survey elements. The population (target group) that we are to deal with is usually too big and we cannot work with every individual unit because time is normally limiting, and/or money or other resources may also be limiting. Even if it were possible to examine every individual, it is doubtful whether the value of the survey results would exceed the cost. In order to overcome these problems we often take a small portion or array of the population /target group that we are dealing with to conduct a survey. This small array/portion is called a "sample". A sample is a representative sub-set of the population targeted by the study. Resource limitation dictates the sample size, and the objective of sampling is to minimise survey costs while ensuring a reasonable degree of accuracy.

Some of the terms that are being commonly used with respect to sampling are sampling frame, sampling unit, cluster and strata. A sampling frame is a list or a map or simply a description of the objects under study or population from which sampling units are selected. A sampling unit is that ultimate unit on which information is to be collected. A cluster is a collection of sampling units. When a population is divided up into homogeneous group with respect to the characteristics to be measured and a sample is selected from each group, then these groups are called strata.

The sample can be drawn in various different ways depending on the nature of the population and the nature of the information that is to be sought. The various methods used in sampling are discussed below.

Sampling Methods

There are two broad categories of sampling: probability sampling and non-probability sampling.

Probability sampling involves drawing a sample such that a particular individual has a known well-established probability of being included in the survey. The main advantages are as follows:

- Minimises risk of sampling bias; and
- Inferences for the population can be drawn with statistically estimable levels of confidence.

Non-Probability Sampling is applicable when it is not practical to draw a sample with the probability of individuals being included in the survey being known.

Probability Sampling Methods

a) Simple Random Sampling

In this procedure the selection is random so that each respondent has an equal chance or probability of being included in the survey and the population must be homogenous. The sampling procedure is done in the following steps:

- Define the population and obtain a population list;
- Assign serial numbers to every member of the population;
- Determine sample size; and
- Use a random number table to select members of the sample.

Advantages

- It is easy and simple;
- Appropriate for homogenous population concentrated in a single area; and
- Each member of the population has the same probability of being chosen.

Disadvantages

- Difficult to obtain a population list;
- Selected units can be geographically dispersed and therefore expensive to reach;
- Provides imprecise estimates if the population characteristics are very variable;
- Non-representativeness especially when population is not truly homogenous; and
- This method is seldom used for practical purposes.

b) Systematic Sampling

It involves choosing every k^{th} unit from the sampling frame. $K = (N/n)$ is the sampling Interval, where N is the total population and n is the sample size.

Advantages

- Easy and quick.

Disadvantages

- Need sampling frame to be in random order, otherwise will lead to biased results.

c) Stratified Random Sampling

In stratified random sampling, one divides the heterogeneous population into mutually exclusive homogenous subgroups and then draws a simple random sample from each group / systematic sampling. The stratification/division into groups is based on predetermined criteria/known characteristics to minimise differences within groups but allowing large differences between groups.

Advantages

- Easy to implement;

- Ensures enough cases in each group therefore increases representativeness;
- The precision of statistical estimates is increased through minimisation of within-group variability; and
- Gets more information from entire population.

Disadvantages

- Prior knowledge of population is required for the stratification.

d) Multi-Stage Sampling

List groups/strata's such as village/districts/zones. The selection is done at different stages. For example, if one is selecting a sample of farmers for a survey covering the entire country, then one could follow the following sequence:

- Stage 1: Selection of zones - randomly or purposely;
- Stage 2: Within Selected Zones - Select districts - randomly or purposely;
- Stage 3: Within Selected Districts - Select villages - randomly or purposely; and
- Stage 4: Within Selected Villages - Select farmers - random or cluster.

Advantages

- Saves travelling time and cost;
- No need for a complete sampling frame; and
- Can build a sampling frame as sampling progresses.

Disadvantages

- Complex; and
- Generalising estimates to population is difficult.

e) Cluster Sampling

This is a special case of multistage sampling. First, divide population into groups/clusters of elementary units, and then randomly or systematically sample clusters. After that survey all elements in the clusters sampled. There is a need to have heterogeneity within the cluster to ensure representativeness. This heterogeneity in the cluster must be similar to heterogeneity in the target population.

Advantages

- The time and costs of travel are reduced; and
- We do not need a full sampling frame, which may be difficult to get.

Disadvantages

- The sample is less representative compared to simple random sampling

Practical Consideration in Sampling

There are several practical considerations in sampling. These aspects are outlined in the following sections;

(a) Defining the Sampling Unit

Defining the sampling unit depends on the purpose of the study. Mostly individual households are used as sampling units.

(b) Obtaining the sampling frame

- List of all units that could be sampled (selected);
- Evaluate all available sampling frames such as extension lists, club membership lists, voter's lists, irrigation parcel lists, co-operative membership lists, and credit union lists etc; and
- Depending on the purpose of study, decide who to interview.

In using an existing sampling frame, weigh magnitude of biases that are introduced against time and money to construct one yourself. This can facilitate valuable comparison. Only make a list if the sampling frame is not available, otherwise use multistage sampling.

(c) Determining the Sampling Methods

Choice of sampling method depends on:

- Survey objectives;
- Nature of research problems;
- Available population lists;
- Fieldwork logistical problems;
- Availability of time and money; and
- Common sense.

(d) Determining the Sample Size

The sample size is determined by:

- Variability of local farm conditions which are reduced by stratifying;
- Required degree of precision;
- Time and monetary constraints (availability);
- Available data handling facilities;
- Availability of trained manpower;
- Questionnaire complexities; and
- In determining sample size;
  (Statistical formula can be used to estimate sample size. However empirical results indicate that 20-25 per group may be adequate for meaningful comparison. Allow for substitution due to: (i) wrong lists, (ii) poor infrastructure/ accessibility, and (iii) selected respondent is not a member of the target group. For an adoption study, 80-120 observations are adequate).

Developing a questionnaire

A questionnaire is the principal instrument of obtaining information from respondents. It is one of the three components of a face-to-face interview consisting of the enumerator, respondent and the questionnaire. A questionnaire is a list (set) of questions which should be clear, consistent, unambiguous, and well focused. Content of a questionnaire is vital for collecting priority information. For adoption studies it is important to develop short, well-focused questions based on specific hypotheses.

Developing Questionnaire Content

The questionnaire content depends on priorities that are dictated by the purpose of the study. It also depends on how the data is going to be used. The main information needs must be listed and data collected should be analysed, i.e., if you are not sure about how you are going to analyse the data, don't collect it.

The content deals with the information to be collected, types of questions included as well as the format. Questions can be factual/or opinion; open or closed.

Factual vs. Opinion

- Factual questions seek facts and opinions are less specific, as they seek what respondent thinks (feel); and
- Opinions are subjective and factual questions are objective.

Open vs. Closed Questions

- Closed questions have predetermined responses, i.e., they are pre-coded with the responses being read out to the respondent;
- Open questions on the other hand do not. There are open spaces where the responses are written down; and.
- For adoption studies, closed questions should be in the majority because they are:
  - Easy to analyse thus making the analysis efficient; and
  - Make the study well-focused by channelling answers

There are four types of formats used in questionnaire development. These are:

- Parallel questions;
- Open-ended questions;

- Closed questions; and
- Tabular format

Wording of questions

Words used in a question should be:

- Simple, clear, explicit and easily understood by interviewer and respondent;
- Adoption questions should be specific, i.e., specific field or land parcels and use local units of measurement;
- In wording questions avoid:
  - Leading questions - in an adoption survey do not tell farmers any recommendation , let them recall, record if they do not remember;
  - Overlapping answers, close to multiple questions e.g., did you use fertiliser and improved seed?
  - Vague terms, i.e., adjectives that do not have the same meaning to everyone, (e.g., frequently, often, fair price, etc).
  - Technical terms, i.e., terms/jargon farmers are not familiar with;
  - Be time and location specific; and
  - The unit of observation should be in local terms and the researcher must be able to translate these into his/her own terms, i.e., such as metric units.

Organisation

Organisation refers to arrangement of questions in a questionnaire.

Order questions in a logical manner, i.e., have a logical layout. For example:

- Introductory questions;
- Identity and location of respondent - title page;
- Questions specific to crop management - main body of the survey;
- Sensitive questions last;
- Order questions to make administration of questions easy and capture and maintain the interest and participation of the respondents; and
- Number all questions, group them into sections - introduce each section;
  - Group questions according to subject mater into sections;
  - Sequence so as to facilitate the linking of preceding and succeeding sections and according to structural organisation of the farms; and
  - Order question within each section and then order section.

Guidelines to ordering sections

In ordering question please ensure

- Introduction of section;
- Move from general to specific, simple to complex, ask for familiar information first then move to less familiar issues;
- Order according to time with recent events first or on subject matter;
- Avoid unnecessary repetitions and irrelevant questions; and
- Provide enough space for answers.

Interviewing

- Assume that questionnaires are ready, translated and pre-tested, that you have recruited and trained enumerators, and informed local leaders;
- The researcher is the main administrator of the survey that is implemented by enumerators. The main objective is to get accurate information from respondents by:
  - → Ensuring village leaders are co-operative. Avoid being a stranger through familiarisation with the area and the survey;
  - → Obtaining farmer co-operation
    - ➢ The researcher should be familiar with village/farmer situations and customs;
    - ➢ Treat information confidentially;

- Timing of an interview to avoid times when farmers are very busy or are engaged in social or community activities; and
- Enumerators' behaviour. Should behave in accordance with local, acceptable cultural values and norms.

→ Supervision of Enumerators
- Identify errors at an early stage to permit re-interviewing

Methodological and logistical issues

The survey supervisor should:

- Help with administration of difficult questions;
- Assist in handling unforeseen problems;
- Checking the questionnaire for errors and omissions, do not allow blank spaces;
- Provide moral support to enumerators;
- Ensure enumerators are actually interviewing farmers and that they have a good relationship with the community;
- Collect completed questionnaires;
- Supply questionnaires and other stationery;
- Provide transport and payment for services rendered by enumerators; and
- Ensure basic facilities for living are provided

Fieldwork design

The fieldwork design is influenced by:

- Size of sample and geographical dispersion;
- Number of interviewers and supervisors available and the time for each interview;
- Days available to complete the survey;
- Accommodation and transport facilities;
- Availability of funds;
- Allow sufficient time for enumerators to complete interview and move to the next respondent;
- Enumerators and supervisors must be familiar with the local area to ensure time is not wasted (both researchers' and farmer's);
- Avoid keeping farmers waiting to be interviewed; and
- Supervisor and each enumerator must complete 2-3 questionnaires together.

Special problems in the field

Some of the special problems that may be encountered are:

- Paraphrasing the questions - translation problems;
- Question order – pre-testing may solve this;
- Accuracy vs. speed of interviews;
- If the respondent is inappropriate terminate the interview diplomatically and seek replacement;
- Explain purposes of the interview to the farmer to avoid refusal. Otherwise, select another; do not force co-operation; and
- If respondent is missing, do not ask next available person; seek information on future availability. If this fails, the last resort is to find a replacement.

There are a number of reasons why replacement may be necessary. Thus, one must have a larger than needed sample size to cater for replacements.

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Research priority setting methods

Introduction

Research is an iterative process. This process is characterised by a number of phases (diagnosis, design, testing, dissemination, feedback and impact assessment) which together constitute the project cycle. Priority setting is necessary in each phase of the research cycle. This is crucial to ensuring that scarce research resources are used effectively and efficiently. Priority setting can be described as an exercise in identifying key problems, then selecting among a number of possible concern of action, seeking the best ways to address these problems. The decisions that must be made in the analysis and definition of problems, the identification and screening of possible solutions and the matching of problems with the solutions are the core of any priority setting process. Priorities are set at different levels within any national research system. The various priority setting techniques are discussed in this chapter.

Different Levels of Priority Setting

The process of setting priorities facilitates rational allocation of scarce research resources. Decisions about allocation of resources to agricultural research have to be made in a number of stages on different (interrelated) scales. At the macro level within agricultural research program the broad balance has to be set between major commodities or group of commodities and problem areas in the light of national and regional priorities. These decisions will be taken at the national or regional level and often conventional quantitative methods are used for this purpose. National level research priorities are usually set top-down, using national indicators (value of production, foreign exchange saving, etc.) social and biological indicators (cultural importance, nutritional value) and resource criteria (availability of trained professionals, likely time scale). Priority setting and research program formulation at national level initially involve a 'top down' resource allocation process. This process is guided by consideration of national resource availability, and its macro allocation and distribution over various priorities, related for example to particular commodities or geographical regions.

At the micro level, priorities have to be set among research topics and individual research projects. These decisions will be taken at the institute level and will involve individual scientists and preferably the beneficiaries. A number of participatory approaches can be used for priority setting at this stage. In general, decisions at the micro level will be taken annually or semi-annually, whereas decision at a higher level will be of a longer term nature, although subject to periodic review.

Priority setting therefore arises at three different levels of research planning.

- At the macro-economic level among research program of cereals, animal production or natural resources management
- At program level among
  - commodities
  - agro-ecological zones/production zones
- At project level between different experiments and studies.

In the majority of NARS priority setting occurs at the following levels

- At commodity level – between commodities;
- Within a commodity on research thrusts – breeding vs. management; and
- Within research thrusts on different technological options.

A simplified view of decision levels for priority setting in NARS is presented in Table 8.1.

Table 8.1: Simplified view of decision levels for priority setting in national research organisations

Decision level	Decision type	Common decision maker in supply-led approaches
National	By program (commodity, factor) sometimes by region across programs	Supreme research body such as agricultural research council or board
Program	By sub-program (disciplinary or technology type) and by region within programs	Research program co-ordinator or institute director.
Sub-program	By project (technology types and characteristics)	Sub-program leader or departmental head
Project	By technology characteristics	Lead scientist for project

Adopted from Byerlee 1999

It is important to remember that priority setting merely ranks activities in their order of importance. Resource allocation is not the same as determining priorities. A high priority project may require little resources. The criteria used at the macro level will be different from those at the micro level.

Need for Priority Setting

For a considerable period in many NARS research resource allocation decisions were heavily influenced by previous years' budget. Changes often result from request by scientists, which are evaluated relatively informally and aggregated into an overall plan. The resulting plan may contribute little to the attainment of national goals and objectives. With the growing pressure on public sector budgets, the potential for Agricultural Research Organisations (AROs) to use scarce resources more efficiently and effectively is widely recognised. The shrinking real research budgets have stimulated several attempts to evaluate economic benefits of agricultural research and to improve procedures for setting priorities among competing research programs. Accordingly, many AROs have instituted formal priority setting exercises to ensure that research resources are allocated in ways that are consistent with national objectives and needs. Judgements based upon prior knowledge and information provided by scientists is crucial for research resource allocation decisions. However the use of quantitative methods may be necessary to improve the objectivity of those judgements. The aim is to foster consistency of research priorities with goals and objectives and to improve the efficiency of the research system in meeting producer and consumer needs. The idea is not to replace judgement but to increase and organise the information available for updating prior knowledge and beliefs.

There are several other reasons for why there is growing need for a more formal approach to priority setting. In most agriculturally dependent countries as rural development lags, more and more is expected of NARS. Often expectations are unrealistic, and there is pressure to obtain results from short-term, adaptive research, without adequate attention being given to longer-term strategic or applied research required to generate new technology. Formal priority setting techniques would reveal where unrealistic expectations lie and will minimise the pressure to enable the managers to counter balance such pressures.

Planners and managers confronted with conflicting national goals need methods to help them make their decisions as well as arguments with which to defend them. A planner/manager who has gone through such a systematic exercise is in a much better position to defend his or her decisions on priorities.

Staff and funds are often allocated on historical basis reflecting past priorities. There may be vested interest in maintaining the status quo. Investments by donors may also reflect their own perceptions, rather than those of the country's needs. Under these circumstances, the formal methods of priority setting may strengthen the managers' hands in directing resources to high priority areas.

Priority setting requires intensive consultation among and between politicians, administrators, planners, researchers and beneficiaries. Formal procedure facilitates this because they systematise the consideration of key variables and allow an interactive process to develop.

Formal priority setting process will also identify the points at which personal research agenda and national interests appear to be in conflict.

Approaches to Priority Setting

A number of approaches ranging from theoretical one person body through the restricted consultative body (top-down) to the consultative interdisciplinary and participatory body (bottom-up) are in use. Priority setting processes are of three broad types or some combination thereof.

Based on historical trend

Here priorities and resource allocation are essentially determined historically, with little or no regard for the need to formalise the process. There is very little or no consultation in this approach.

Problems/disadvantages of this approach are:

- Research systems following this procedure are likely to have a stereotyped research programme.
- Programs do not reflect the producer needs and national development goals.
- Run the risk of reduced budgetary support from government.

Top-down approach

Here the decisions are made by a few key research administrators and senior scientists. This approach excludes the participation of other stakeholders who could contribute substantially towards meeting the overall objectives of the sector.

Problems/disadvantages of this approach are:

- Decisions made by such groups more often than not, do not address the real constraints, but reflect political demands and individuals training and interests.
- Emphasis usually placed on short term macro-economic considerations, such as improving foreign exchange earnings or achieving national food self sufficiency.

Bottom-up approach

These approaches involve all relevant stakeholders. Therefore, being participatory and interdisciplinary in nature, it may involve government, non-governmental organisations (NGOs), local communities, and private sector in setting priorities. This process is more likely to include real down to earth objectives and constraints with an enhanced chance of research generated technology adoption and impact.

Only this approach provides a really suitable basis for the introduction of more formal priority setting methods.

Priority Setting Methods

Priority setting is carried out explicitly or implicitly in all research programs through allocations of research resources to different commodities, regions, disciplines, problems and type of technology. In agricultural research organisations, priority setting occurs at various levels of decision making – most commonly at the national, program, sub-program and project level. Resource allocation questions and methods employed vary depending on the level at which priorities are set.

Priority setting in practice employs a range of methods that can be broadly classified into supply oriented and demand oriented, although some combination of approaches is often used. In supply-oriented approaches priorities are largely set within the research system. A variety of methods might be used from informal methods based on previous allocation (i.e. precedence), discussions and consensus among research managers taking account of national agricultural strategies and formal quantitative methods using scoring models, congruence, domestic resource cost ratios, mathematical programming or simulation techniques. In demand-oriented approaches priorities are set based on perspectives of major stakeholders from outside the research system, especially users. These might employ consultative and participatory methods or users themselves might be empowered to make decisions on research priorities (e.g. through representation in governance of AROs or agricultural research councils). The various formal methods employed in research priority setting are discussed in the following sections.

Supply oriented methods

Congruence analysis

Here assuming other things are equal total available research funds should be allocated to commodities in the same proportions as their existing contribution to agricultural domestic product. Congruence can only be directly applied to programs based on commodities.

The congruence concept is expressed by the formula:

$$C = 1 - \sum_{i=1}^{n} (A_i - S_i)^2$$

Where:

A_i is the share of a particular commodity in research budget and S_I is the share of that commodity in agricultural value added. Perfect congruency occurs when C is equal to 1 for *n* number of commodities. The congruency analysis can be thought of as a special case of scoring or weighted criteria model with all the weight placed on the criterion of value of production.

The disadvantages of this method are:

- It favours commodities that are already well established, discriminating against new ones and those with low current values.
- Financial outlay might justifiably be lower than congruence dictates for commodities heavily researched elsewhere and those with limited research needs.
- There is no place in the procedure for non-commodity research.
- As a planning tool its usefulness is limited; it may show however that important commodities are being neglected.
- Congruency essentially score commodities according to a single criterion, value added by the commodity.

Checklist approach

Several studies have established multiple criteria for ranking priorities because of the desire to explicitly consider a wide variety of factors that do, or perhaps should, influence research. Checklist is the least sophisticated approach in using this multi-criteria method. This approach can greatly improve the quality of priority setting at lesser extra cost. The important step in the procedure is to identify the criteria to be used. In general, most questions related to criteria revolve around three areas: the impact of research, its cost and its feasibility.

For NARS which currently rely entirely on historical allocation and personal judgement, use of a checklist is probably the most appropriate initial approach to priority setting. This technique is simple to apply, but it does require much understanding of both agricultural research and development. The checklist can be expanded into a 'scoring model' by attaching weights and scores to the criteria it lists. Even when more sophisticated methods like benefit-cost analysis are used a checklist should still be used to insure against omission of important considerations. This approach also can be used in demand oriented methods.

Scoring method or weighted criteria model

Scoring method is a more sophisticated version of the checklist technique. The scoring matrix is really no more than a checklist with the answers to questions assigned numerical values and weights. Criteria weights are multiplied by the values which a particular research program merits under each criterion to produce a final score. Program can then be ranked in order of priority according to their scores.

Setting agricultural research priorities through scoring involves selecting a set of broad research objectives (for example efficiency, poverty alleviation, equity, food security, environmental protection, employment generation) and establishing indicators (criteria) of research contributions to the attainment of those objectives (indicators such as the value of production, the cost of research, probability of research success and expected adoption level). Commonly used elements in the weighted criteria model for ranking research priorities by commodity are presented in Figure 8.1. Relative weights are assigned to objectives and/or criteria and weighted average scores are calculated for each commodity or research area. An interactive process of refining assumptions and estimates should be used to arrive at a final set of parameters and data analysis. Commodities or research programs are then ranked according to each objective and these rankings are multiplied by the weight to derive a final composite ranking and a list. The resulting ranking may be compared against the current set of research priorities, and judgements may be made about future allocation of resources available for research.

Scoring methods only facilitates the ranking of various options but does not assist in the allocation of resources to each commodity or research area.

Steps in the process:

i) Develop commodity or research area list.
ii) Identify set of broad objectives - if necessary elicit weights on objectives.
iii) Identify criteria of achievement reflecting their relative importance.
iv) Elicit weights on criteria.
v) Collect quantitative and qualitative data - largely from secondary sources and through group interaction.
vi) Weighted average scores are calculated for each commodity of research. Use the weights to calculate a single measure of the overall contribution of project/program to the combined set of objectives - scores.
vii) Derive rankings by commodity or research area.
viii) Analysis and interpretation of results.

An illustrative example of setting research priorities for sorghum and millet for SADC member countries using scoring method is presented in Table 8.2.

Advantages of this method are:

i) Scoring method is particularly useful when data, time and analytical capacity are limited.
ii) Scoring methods are useful when dealing with widely differing types of objectives such as economic efficiency, equity and conservation of natural resources.
iii) Simple scoring methods do not require advanced quantitative skills. The approach is straight forward and can be applied without any special training.
iv) Can be used to rank a long list of commodities or programs even when only qualitative information is available.
v) It causes decision makers to make conscious choices between multiple objectives.
vi) It can use both qualitative and quantitative data and is quick to apply.
vii) Data requirements are very modest, but experience and knowledge both broad and deep are essential.

Short comings of scoring methods are:

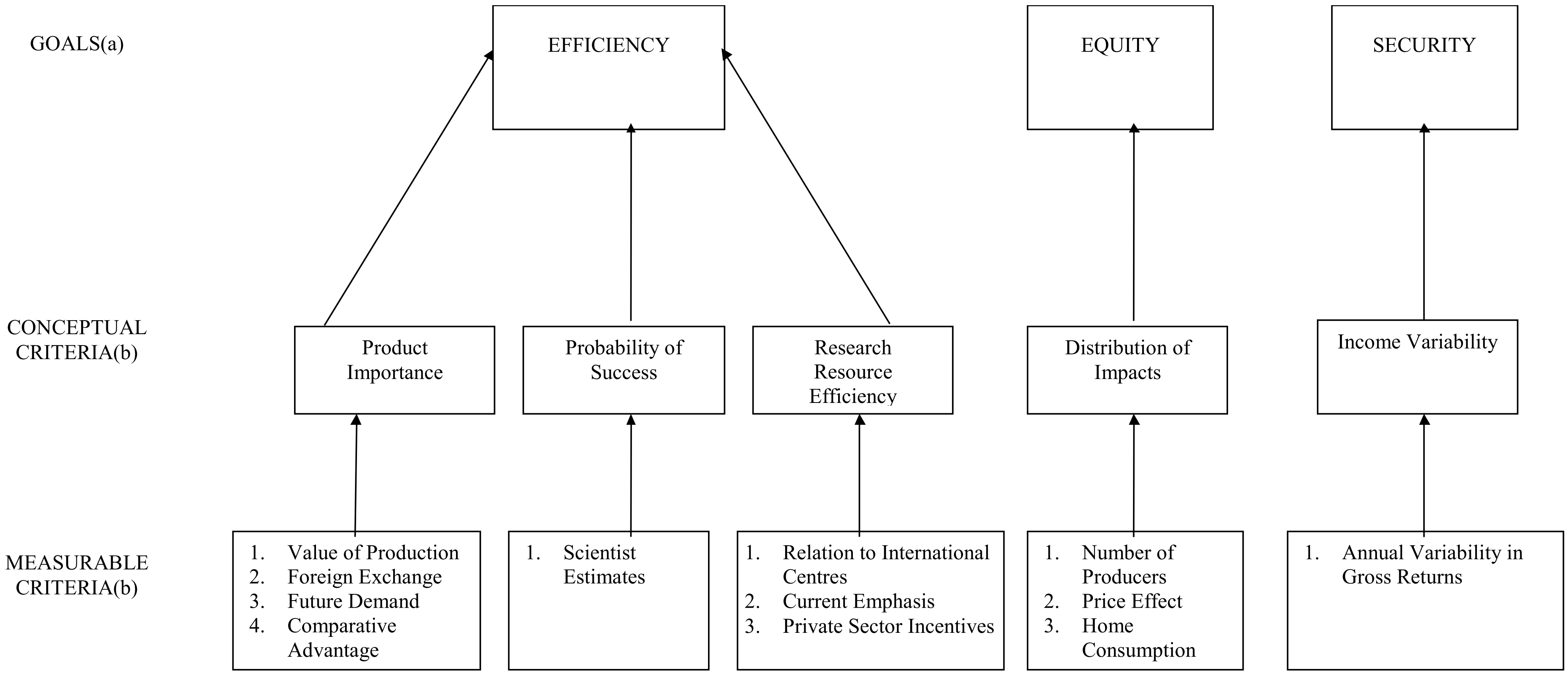
i) Use of poorly measured or overlapping criteria for determining research contributions - tends to arise where objectives and measures are stated and not carefully checked for logic and consistency.

ii) Confusion between objectives for the research system and the criteria/indicators used to assess their attainment - weights that should have been placed on the objective have often been placed in the criteria and/or the indicator.

iii) Overly simple methods of measuring contributions of research to economic efficiency or production often fail to discount future benefits and costs, to account for technology transfer across geographic areas and to consider the effects of agricultural policies.

iv) Weights assigned to objectives are highly subjective - a criticism which applies to all priority-setting procedures.

Figure 8.1: Conceptual elements in the weighted criteria model for ranking research priority by commodity



(a) Additional goals might be "Poverty Alleviation" and "Environmental Protection".
(b) Nutritional Criteria could be included as additional measure of distributional impacts.

Table 8.2: Scoring Research Areas for Sorghum and Millet for SADC Member Countries

RESEARCH AREA/ ACTIVITY	Impact on Yield[1]	Regional Spread[2]	NRM[3]	Gestation[4]	Chance of Adoption[5]	Total Score[6]	Ranking
CROP IMPROVEMENT							
- Drought tolerance	3	1	1	2	1	108	1
- Pests and diseases	2	1	1	3	1	108	2
- High yield varieties	3	2	2	2	2	864	3
- Grain type	3	2	2	2	2	864	4
CROP MANAGEMENT							
- Crop establishment	2	2	1	1	1	72	1
- Fertiliser management	3	3	3	1	2	972	6
- Soil and water management	1	2	1	1	2	72	2
- Intercropping	3	3	1	1	2	324	5
- Weed management	1	2	2	2	1	144	3
- Pest and disease control	3	2	3	1	2	162	4
POST-HARVEST TECHNICAL							
- Processing and utilisation	3	1	2	1	1	54	1
- Storage	3	2	2	1	1	216	2

Source: SACCAR 1997

1 Potential impact is measured in terms of productivity gain if >15% considered high and a score of 1 is assigned, 10-15%, medium score of 2, <10% low a score of 3
2 Regional spread more than 5 countries, high, score of 1; 3-5 countries, medium and a score of 2; less than 3 countries low and a score of 3.
3 Natural resource management, effect is positive then a score of 1; neutral score of 2, negative a score of 3
4 Gestation period less than 5 years a sum of 1; 5-10 years a score of 2; and more than 10 years a score of 3
5 Chance of adoption if considered high a score of 1 and low a score of 2.
6 In deciding the final score potential impact on productivity and regional spread are considered to be three times and environmental impact is considered to be twice as important as gestation period and chance of adoption.

There is always the possibility that the personal judgement which lie behind the determination of weights and scores may result in misleading conclusions.

When looking at final scores, decision makers may conclude that they do not accord with common sense. If this happens, they may wish to adjust the values, and sometimes the weights, until a result emerges which is more reasonable to them. The process of adjustment should not be carried out too far; results should not be manipulated until they merely reflect existing prejudices.

The procedure of establishing criteria and using weights to arrive at a final set of research priorities has the advantage of forcing decision-makers to continuously trade-off multiple goals. The procedure is relatively easy for administrators to understand, but does require their time in obtaining the explicit weight for criteria. The method also requires scientists' time to collect information on qualitative criteria. As a result the approach is better suited for periodic or major priority-setting efforts than for situations where frequent marginal changes are anticipated.

Domestic resource cost (DRC) ratios

DRC ratios indicate where a country's comparative advantage over other producers in the world market lies. The concept is embodied in a simple formula:

$$DRC\ ratios = \frac{A}{B - C}$$

where:

A	=	Domestic value added per unit of output or a given commodity.
B	=	Foreign exchange earnings or savings per unit of output.
C	=	Foreign exchange cost of imported inputs per unit of output.

All values should be expressed in international or border price terms, otherwise the ratio will not reflect the genuine opportunity cost of the resources involved.

If the country in question can produce and deliver a unit of a given commodity to a consumer at lower cost than other countries, this means that the domestic labour, land, water and capital which go into its production, i.e., its value added (A) will be larger than the unit cost of the equivalent items produced abroad (B) minus the unit cost of the imported inputs which have gone into domestic production (C).

A DRC ratio of less than 1 shows a comparative advantage in the production of a commodity, whereas a ratio of more than 1 shows a disadvantage. In using this method it is implied that the lower the DRC ratio, the more resources the country should allocate to research on the commodity in question.

Disadvantages of this approach are:

i) Comparative advantage may be confined to a certain group of production only, e.g. plantation workers vs. poor farmers.

ii) Where a country attaches much weight to self-sufficiency DRC ratios cannot be used to set this objective aside, only to question its rationality.

Benefit-cost analysis

Benefit/cost analysis compares the time valued estimate of the net returns from the results of a research program as farmers adopt them with the time-valued cost of the research itself. The changing value of variables overtime and their changing relation to one another, are taken into account. The approach is based on a concept of discounted cash flow - the premise that a dollar made a year from now is worth less than a dollar earned today - because of the interest earning potential lost during the intervening period. While methods vary in complexity, most have applied a variant of the economic surplus approach to allocate resources across commodities at the national level. Most commonly, economic surplus to consumers, ΔCS_i; producers ΔPS_i and the total, ΔTC_i is computed for each commodity

$$\Delta CS_i = P_i Q_i Z_i (1 + 0.5\, Z_i\, \eta_i)$$

$$\Delta PS_i = P_i Q_i (K_i - Z_i)(1 + 0.5\, Z_i \eta_i)$$

$$\Delta TS_i = P_i Q_i K_i (1 + 0.5\, Z_i \eta_i)$$

where: K is the proportional shift in the supply curve: P and Q are respectively the initial price and quantity of the commodity, η is the elasticity of demand (absolute), β is the elasticity of supply. $Z = K\beta/(\beta + \eta)$.

If efficiency is the main decision making criterion, commodities can be ranked according to the net present value (NPV) of the stream of benefits, net research costs, per unit of investment in research on the commodity (Alston, Norton, Pardey, 1995). This basic economic surplus approach can be extended in many ways. For regional allocation of research resources, geographical information systems are increasingly being applied to spatially characterise and map research or problem 'domains'.

The expected surplus approach using the benefit-cost framework has the major advantage of incorporating several criteria related to economic efficiency and distribution into one or two measures. It can also be used to examine the general equilibrium effects of research and the benefits of research under alternative, possibly distorting domestic policy and international trade. This approach provides a framework for thinking clearly about the impact of new technology on society at large. This framework can be kept simple, and it can make use of assumptions in place of hard facts, yet still be worthwhile. It comprises, at minimum, the sequential estimation of eight distinct characteristics of a research program and its impacts. They are: annual research costs, duration of research, its probability of success, on-farm implementation costs, resulting benefits, rate of adoption, adoption ceiling and life of innovation. The concept of producer and consumer surplus are important in any application of benefit/cost analysis for programs developing new technology, for without them it is impossible to predict the distribution of benefits between early adopters, late adopters and consumers.

Once again some common sense is required when applying benefit-cost methods. Care must be taken to address the uncertainty surrounding the assumptions underlying the calculations. Some research programs typically have a high risk of failure, or may take a long-time to reach a successful outcome, but are certain to have a large impact if they do succeed. In some other cases the outcome and time scale can be predicted with some confidence, but the rate of adoption by farmers is very uncertain e.g. a plant breeding research project or programme. Sensitivity tests are often used to handle uncertainty. Expected surplus can be estimated under optimistic and pessimistic conditions.

The issue of international and in-country spill-over especially for regional projects also needs to be addressed. If the necessary calculations with respect to the distribution of benefits, both within and between nations can be carried out and some confidence placed in the results, governments and donors will have a picture of what countries, regions, and the income groups are likely to benefit from a particular line of research.

The major advantages of this method are:

- Alternatives are not simply ranked but quantitatively assessed one against another.
- The rates of return (ROR) that is calculated has the great merit in that it allows research investments to be compared with public investment in other sectors.
- It has the advantage of incorporating several criteria related to economic efficiency, environmental and equity considerations into one or more measures.

The disadvantages of this method are:

- This procedure requires a high level of understanding of economic analysis, and more analyst time than the weighted criteria model, but less administrators' time.
- It can be difficult to apply to a large number of commodities or research areas because certain type of data necessary for the analysis often do not exist for all commodities.
- It is difficult to accommodate the effect on commodity prices.

Mathematical model or programming approach

The mathematical programming approach is similar to the weighted criteria model/approach because weights are places on a set of goals or criteria. The model relies on mathematical optimisation to choose a research portfolio through maximising a multiple-goal objective function given the resource constraints of the research system. The model calculates the optimum combination given the budgeting, manpower and other constraints on the research system. In this approach trade-offs among different goals are easily quantified.

The procedure has the advantage of explicitly considering the budget, human resource and other constraints on the research system. Unless the constraints are well specified, including possible changes overtime, there is a risk of getting a nonsensical solution.

The model is more intensive on economic analysis, time and ability than the simple weighted criteria approach and decision-makers may be less willing to accept what appears to be a 'black box' solution.

Simulation model

The simulation model as the name implies simulate the functioning of a system and are particularly useful in exploring what is likely to happen under a variety of scenarios. They readily incorporate stochastic variables.

The advantage of simulation models is their flexibility. They can be constructed as relatively simple or complex tools, can incorporate optimising or ranking procedures, and can readily include probabilistic information. The major disadvantage is that, to be useful, they must be relatively complex and typically require extensive amount of both data and time of skilled analyst.

All these supply-oriented methods differ greatly in data requirements, ease of application and interpretation. A comparison of the major agricultural research priority setting methods is presented in Table 8.3. Benefit-cost approach, programming and simulation methods may bring major precision in decision making but they require substantial amount of high quality data; a very precise definition of the research programs that are being compared and prioritised, and often hard to understand by layman. The mathematical and simulation models are highly sophisticated and require substantial data and skilled analysts. They are only as good as the assumptions on which they are built and the data that go with them. The congruency method and checklist approaches are much less data intensive, but are often not capable of capturing the variety of considerations that enter into the process of priority setting. Scoring methods on the other hand uses both qualitative and quantitative data and is simple to manage when the data availability and analytical skills are limited. Scoring method is fairly widely used in most developing countries.

Demand oriented methods

Within the emerging participatory approaches to technology development and transfer simple techniques are often used in setting priorities. In a participatory approach it is quite common for qualitative data to be collected. For example during diagnostic surveys within a target group information may be collected on the types of enterprises, the problems encountered in production, etc. It may be necessary to draw conclusions from such types of data. In those circumstances ranking, rating and sorting are tools used to make choices and set priorities. This is particularly important in prioritising problems and solutions, as often there are many problems out of which only a few more important ones have to be selected.

Regardless of the purpose of ranking the following procedures are usually followed.

First, it is important that the participants are informed about the objectives of the exercise. This is very important because if the community does not understand why they should rank the items at hand, they may not give adequate information and hence no meaningful discussions can take place.

Secondly, it is equally important to explain the procedures to be followed. This includes explaining the roles of the facilitator and that of the participants. Where necessary, if some objects (sticks, stones, cards, etc.) are to be used, it may be useful to demonstrate how they will be used, scored and recorded. Illustration of the use of diagrams, charts, tables, etc., should also be done either on a flip chart, or on the ground.

Following the above, the items (e.g., problems, needs, priorities, enterprises, etc.) to be ranked are identified and listed together with the group. If the items had been identified earlier (say through key informants, secondary data, etc.) the participants should agree/amend the list of items or criteria. The items/criteria should be in the local language and where possible the use of symbols to represent them should be encouraged so that the illiterate participants can also follow appropriately.

Once the listing has been agreed upon through consensus, the participants will then be asked to rank each of them depending on the type of ranking being carried out. However, it is important to encourage the group members to think aloud. It is also beneficial to ask the group to probe and explain why each item is ranked as it has been. It should be noted that the participants may be split into smaller groups in order to (1) allow comparison of results from the groups' male, female and youth participants; and (ii) allow discussion of sensitive issues by women without fearing their spouses.

Finally, it is important for each group to summarise and repeat the order of ranking together with the reasons given in order to ensure that group members are able to verify what has been recorded.

Table 8.3: Comparison among major agricultural research priority setting methods

Characteristic	PRIORITY SETTING METHOD			
	Weighted criteria	Expected econ. surplus	Math programming	Simulation
Operational considerations				
1. Relative cost in researcher's time	medium	medium	medium	high
2. Relative cost in priority setting analyst's time	medium	medium	high	high
3. Relative cost in administrator's time	medium	medium	medium	medium
4. Relative overall data requirement	medium	medium	medium	variable
5. Relative ease of comprehension by decision maker	high	medium	low	low
6. Ease of incorporating subjective information	high	high	low	low
7. Ease of incorporating non-quantitative information	high	low	low	medium
Goal-related issues				
8. Requires explicit elicitation of goals	yes	usually	yes	usually
9. Can determine distribution affects on consumers and producers at various income levels	no	yes	no	yes
10. Can handle uncertainty	yes	yes	yes	yes
11. Can consider trade-off among multiple goals	yes	sometimes	yes	yes
Criteria-related issues				
12. Can consider private-sector research incentives	yes	difficult	difficult	yes
13. Can consider economic policy and trade effects	yes	yes	yes	yes
Evaluation-related issues				
14. Can be used to set priorities for research at the aggregate level	no	yes	no	yes
15. Can be used to set research priorities at the commodity level	yes	yes	yes	yes
16. Can be used to set research priorities for non-production and non-commodity oriented research	yes	difficult	yes	yes
17. Can be used to set priorities for basic research	yes	difficult	no	sometimes
18. Can evaluate secondary impacts of research on employment, environment, nutrition	yes	sometimes	sometimes	yes
19. Usually estimates a rate of return to research	no	yes	no	sometimes
20. Can quantify geographic spill-over effects	no	yes	no	yes
21. Can consider the lags involved in research and adoption	yes	yes	yes	yes
22. Facilitates priority setting when the number of commodities is large	yes	difficult	difficult	difficult

Source: Adopted and modified form Norton and Davis ( )

When making comparisons between the rankings of different groups/respondents, or when combining the rankings from different sources, it is important to probe into any substantial discrepancy or inconsistency in the trend of ranking for an item.

It is also important to note that in ranking crop enterprises; intercrops should be treated as single crop enterprises as the inputs, management and outputs involved are different from those of the component parts.

The various ranking methods used in the participatory approaches are summarised below

Card Sorting

The most common techniques for ranking, which has been widely used especially for social stratification is card sorting. Here informants sort cards which represent the different strata into piles. Local material such as beans, seeds, leaves, sticks, stones or whatever is at hand, are ideal as scoring devises when cards are not available. There are other scoring techniques, such as free scoring and scoring out of a maximum.

Single List Ranking or Preference Ranking

This involves preparing a list of items (e.g., problems, preferences) and asking participants to order them by importance, value etc. For each ranking, particularly the most and least important ones, the participants should be asked to give some qualitative insights, explanations and ideas regarding their decision and reasons for ranking. Thus, in this approach, there is no list of criteria for ranking. However, there are three variants of this method. These variants are discussed in the following sections:

Table 8.4: Single list ranking by a group or respondent

Problems in coffee production	Ranking
Drought	1
Pests	2
Weeds	3
Input costs	4
Labour shortage	5

Table 8.5: Single list ranking by many groups or respondents

Problems identified	Respondents						Total score	Ranking
	A	B	C	D	E	F		
Drought	2	1	1	3	2	1	10	1
Pests	1	2	3	2	1	2	11	2
Weeds	3	4	2	1	5	4	20	3
Input costs	4	5	4	5	3	5	26	5
Labour shortage	5	3	5	4	4	3	24	4

In this example, it would be necessary to probe into why respondents B and F gave a ranking of 3 to labour shortage. Further questioning might indicate that they belong to different recommendation domains.

Table 8.6: Single list ranking by many groups or respondents

Problems identified	Respondents						Total score	Ranking
	A	B	C	D	E	F		
Drought	4	5	5	4	3	4	25	1
Pests	2	4	2	1	3	2	13	2
Weeds	2	1	1	3	2	1	11	3
Input costs	1	0	1	1	1	2	9	4
Labour shortage	0	1	1	1	1	1	4	5
Number of stones	**10**	**10**	**10**	**10**	**10**	**10**	**50**	**-**

In this example, the respondents were given 10 stones each and asked to distribute them among the five problems (the largest number of stones being given to the most important problem). Hence, the problem with the highest total score is given first ranking as shown.

Table 8.7: Weighted respondent's scores

Problems identified	Respondents	Total	Total	Ranking

	A	B	C	D	Score	Weighted Score	
Drought(3)	4	5	5	6	17	51	1
Pests (2)	2	3	2	2	9	18	2
Weeds	2	1	3	3	9	9	3
Input costs	2	0	2	1	5	5	4
Labour Shortage	1	1	1	1	4	4	5

In the example shown in Table 8.7: Weighted respondent's scores; four groups of participants were asked to rank the five problems. Drought is considered as the most important problem, followed by pests. Participants decided to give a weight of three for drought and a weight of two for pests. These weights were then applied on the number of respondents who gave response on each type of problems. Based on this, drought, which produced the highest total weighted scores, became the most important problem as shown in the table 5.8. Note although both pests and weeds got the same unweighted score but when weights were applied, pests became the second most important problem. So weights can change the rank ordering.

Pair-wise ranking

In this method, only two items are compared at a time. Hence the number of items should be small so that all possible pair-wise combinations can be made. Again, reasons for the preferred or highly, rated item should be entered in the box. For instance, if groundnuts are preferred instead of sunflower, then groundnuts are recorded in the table as shown in the two alternative presentation methods below.

Table 8.8: Pair-wise ranking: presentation method (a)

Crop	Groundnuts	Cowpeas	Green grams	Bambara nuts	Sunflower
Sunflower	Groundnuts	Cowpeas	Green grams	Sunflower	-
Bambara nuts	Groundnuts	Cowpeas	Green grams	-	-
Green grams	Groundnuts	Cowpeas	-	-	-
Cowpeas	Groundnuts	-	-	-	-
Groundnuts	-	-	-	-	-
Total count	**4**	**3**	**2**	**1**	**0**
Ranking/farmer preference	**First**	**Second**	**Third**	**Fourth**	**Fifth**

Table 8.9: Pair-wise ranking: presentation method (b)

Crop	Groundnuts	Cowpeas	Green grams	Bambara nuts	Sunflower
Groundnuts	-	-	-	-	-
Cowpeas	Groundnuts	-	-	-	-
Green grams	Groundnuts	Cowpeas	-	-	-
Barbara nuts	Groundnuts	Cowpeas	Green grams	-	-
Sunflower	Groundnuts	Cowpeas	Green grams	Sunflower	-

Table 8.10: Summary of pair-wise ranking using method (b)

Crop	Total count	Ranking/preference
Groundnuts	4	First
Cowpeas	3	Second
Green grams	2	Third
Bambara nuts	0	Fifth
Sunflower	1	Fourth

Direct Matrix Ranking or Scoring

In direct matrix ranking, first of all a set of alternatives, items or objects to be ranked are identified by the participants and the major criteria they think are important in ranking them are listed. Then, each item is scored depending on its significance or relevance on the scale of the criteria being used. The scale can take the following forms:

(a) Numbers one to *n* (n = number of items being ranked); and
(b) Numbers zero to a constant maximum number in, say 10.

The example below shows the use of two types of scales. In method (a), $n = 4$ livestock types which are being ranked. In method (b), while using for each criterion, the participants can be given 10 stones or objects and asked to put as many of the objects as they see is necessary to signify the importance of the criteria for the given item. An item for which the current criterion is irrelevant or least important may get a score of zero.

After scoring all items based on criteria, the total scores are compared. In method (a) the item with the smallest total score is ranked as first. On the other hand, in method (b) the item with the highest total score is ranked as the first. Thus, this method quantifies differences between choices and importance of criteria.

Table 8.11: Direct matrix ranking for livestock enterprises: Method (a)

Criteria	Cattle	Sheep	Pigs	Goats
Marketability	1	2	4	3
Rate of production	1	3	2	4
Ease of management	2	3	4	1
Ease of feeding	2	3	4	1
Resistance diseases/pests	1	4	2	3
Cultural uses	3	2	4	1
Good taste	3	1	4	2
Ease for conversion	1	2	4	3
Monetary value	4	1	3	2
Total	**19**	**21**	**31**	**20**
Ranking	**First**	**Third**	**Fourth**	**Second**

Table 8.12: Direct matrix ranking for livestock enterprises: Method (b)

Criteria	Cattle	Sheep	Pigs	Goats	Total
Marketability	4	2	1	3	10
Rate of production	2	1	4	3	10
Ease of management	3	2	2	3	10
Ease of feeding	3	2	2	3	10
Resistance diseases/pests	3	2	3	2	10
Cultural uses	4	2	0	4	10
Good taste	4	1	1	4	10
Ease for conversion	3	2	2	3	10
Monetary value	4	1	2	3	10
Total	**30**	**15**	**17**	**28**	**90**
Ranking	**First**	**Fourth**	**Third**	**Second**	**-**

Difficulties in Applying Priority Setting Methods

There are difficulties in applying formal methods for setting research priorities. The main ones are:

- Comparing the different type of research programs found in national research system. Programs may be organised around commodities, components of natural resource base (soils) social and economic factors (policy issues), agro-ecological zones, administrative regions or types of research (basic, strategic, applied and adaptive). Such divisions are not themselves research categories in the sense of programs among which priorities can be set.
- Getting agreement on the joint approach to priority setting among the many different bodies allocating research funds in a decentralised decision-making system - harmonisation of methodologies is needed.
- Formal methods require information concerning the costs of research, the chances of success, likely adoption rates, environmental impacts, etc. Obtaining this and using it implies much interaction between research institutions and planning authorities, and the mechanisms for this may not exist.
- Dealing with the uncertainty regarding adoption rates, length and cost of research.

- Getting detailed information on program cost and attributing the cost of essential services to individual programs.
- Dealing with social and political objectives which may have value to society which is different from that indicated by monetary costs and benefits alone. These social gains can only be quantified by using weights agreed to by all parties to the priority-setting process, but which nonetheless will remain somewhat arbitrary.
- Mobilising the necessary expertise for formal priority setting. Some of the approaches demand substantial amount of reliable data, or a high level of forecasting ability, neither of which may be available.

It is worth noting that demand-led and supply-led approaches are not mutually exclusive. There are good examples of combining formal supply-led priority setting with participatory approaches. Workshop type situations, in which clients and other stakeholders participate, can be used to define the main parameters for the economic surplus approach and arrive at final priorities. These approaches are likely to result in much better ownership of the resulting research priorities by major stakeholders and a greater chance that priorities will be translated into actual resource allocation. Participatory approaches have been implemented to enhance both the efficiency and equity impacts of research systems. Even imperfect participation and empowerment of the beneficiaries is likely to produce better results than conventional supply-led approaches on both efficiency and equity grounds, since it improves the probability of broad-based adoption.

Research priorities are set at both micro and macro level. More formal quantitative methods are used as macro level and participatory methods are increasingly being used at the micro level. Priority setting methods are very useful in allocating resources among applied and adaptive research programs and projects. The formal methods are of very little use in assisting managers to allocate resources between basic strategic and applied research. It is worth noting that the changing institutional environment in which research is being conducted, reduce the role of formal economic analysis in priority setting e.g. there is a growing push for privatisation of applied research for commercially oriented crops.

Research priority setting is also being increasingly decentralised through a variety of mechanisms. The growing participation of beneficiaries in research priority setting at various levels is a healthy trend. Competitive funding mechanisms are also leading to a reduced emphasis on macro-level priority setting. In some cases these trends have led to a highly dispersed and diverse portfolio of projects that might respond to local needs but do not aggregate to a coherent program consistent with national objectives. The challenge is to develop a judicious blend of bottom-up and top-down approaches to priority setting. Thus students should be exposed to both supply oriented and demand oriented approaches to priority setting.

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Strategic Planning

Introduction

Most of the agricultural research organisations in ESA countries are passing through a difficult period. The on-going economic reform process has contributed to significant changes in the R&D environment including declining funding, decentralisation of research and extension services, increased participation of private sector and non-governmental organisations, downsizing of research, extension and training system and institutional restructuring. Many of the research systems are going through a strategic planning process as a means of searching for new structures, approaches and methods that will ensure sustainability of their institutions and efficient use of scarce resources. The various steps involved in the strategic planning process are outlined in this chapter.

Definition of Strategic Planning

Strategic planning is a process by which the members of an organisation envision the organisation's future and develop the necessary structure, resources, products, procedures and operations to achieve that future. This vision of the future state of the organisation provides both a direction in which the organisation should move and the energy to do it. A strategy is a course of action chosen from a number of possibilities to reach the long-term vision or goal. Strategic planning is a social process of communication, learning and negotiation.

Strategic planning in agricultural research emphasises the diagnosis of the environment and the clear identification of the needs of clients, beneficiaries and users. It seeks consensus in the characterisation of the demand, and therefore in what will be the institutional products to ensure that these products are actually required by users.

Strategic planning emphasises the needs to identify changes in the environment, not just in terms of current situation, but also with special interest in the longer-term. This is of particular significance for research institutions, because their activities must always try to be on the frontiers of knowledge and oriented toward future needs. Strategic planning can help institutions to adapt to changes, prepare for the future and improve their sustainability and overall competence. The long term strategic plan can only become a reality if the tactical plans for the medium term are derived from it, and the operational plans for the short-term are derived from the tactical plans. Thus planning for the short, medium and long-term should be interdependent and complementary. The relationship between the different levels of management, objectives, types of planning and time horizon are summarised in Figure 9.1.

The guiding principles of a strategic planning process are:

- Planning must be holistic;
- Planning must promote continuous learning and adaptation;
- Planning must be participative. This emphasises the importance of the process over the product;
- Planning must continuously involve all inter-related parties;
- Planning requires the commitment of all parties;
- Planning requires co-ordination. This principle recognises the interdependence of institutional components and activities
- Planning must include a system for evaluating the planning process itself.

Purpose of strategic planning

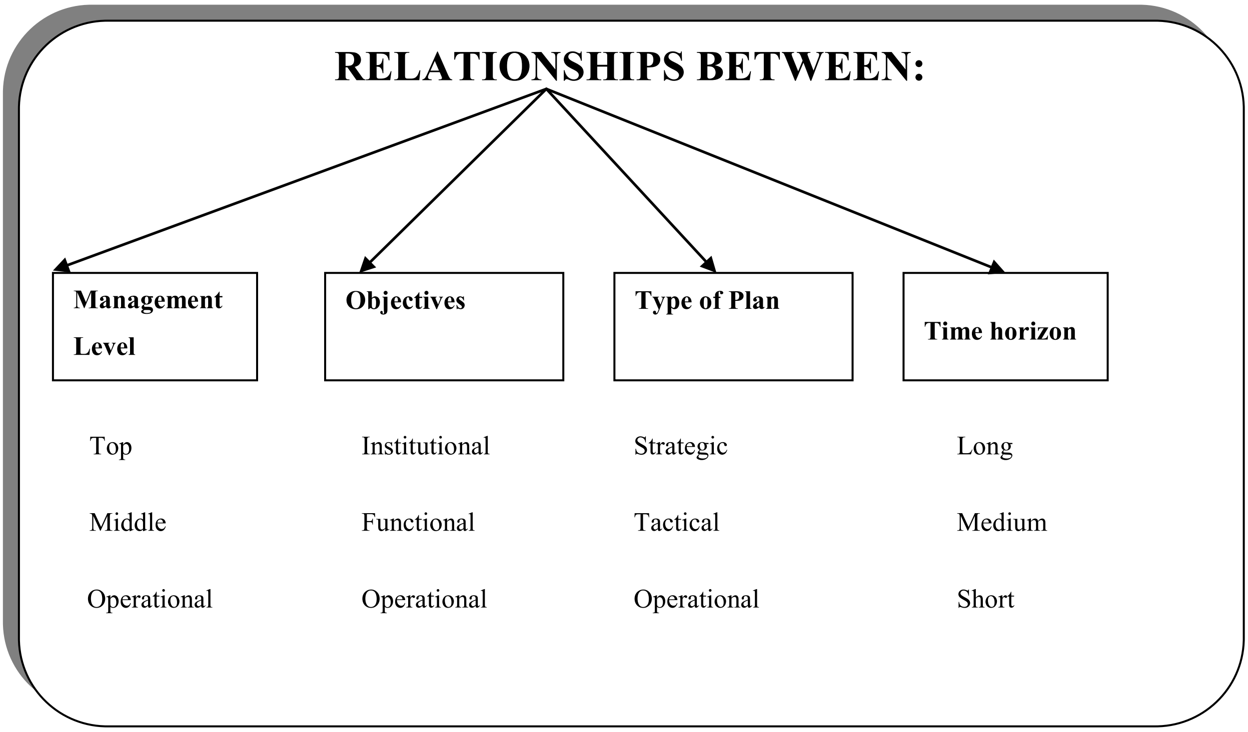
Strategic planning is long-term in nature (5 or more years). It serves as a base for tactical and operational planning. Strategic planning process allows an organisation to:

- Determine its future direction;
- Set priorities;
- Ensure that everyone is moving in the same direction;
- Define criteria for making decisions;
- Make decisions across functions or levels;
- Solve important organisational problems;
- Improve organisational efficiency;
- Resolve conflict; and

- Build team work

Figure 9.1: Management levels objective and types of planning in a time perspective

Source: ISNAR 1995



Planning to plan

Planning to plan serves six major functions: to emphasise top management's commitment, to set the planning horizon, to outline the major steps or tasks, to list the people who will be involved, to set the sequence and timetable of events and to identify barriers.

A strategic intention is a pre-requisite for effective strategic planning. This *'strategic intention'* is a combination of;

- Future vision – a 'vision' of the future for planning oriented by the strategic approach;
- Confidence of its usefulness – the 'confidence' that the strategic approach applied to planning will strengthen management;
- Political support – the 'political will' to transform the vision into reality;
- Political decision – the 'political decision' to put the strategic approach to planning into practice; and
- Political courage to face the inevitable risks.

The strategic approach to planning has two dimensions one instrumental and one behavioural. The instrumental dimension includes conceptual and methodological elements and instruments. The behavioural dimension is essential for building the strategic intention necessary for success.

There may be a need to appoint an interdisciplinary committee. This committee should be supported financially, politically, logistically and technically. Financially the committee needs enough funds to carry out the whole process. Politically the committee must be able to count on direct participation from top management at all times. Logistically it must have all materials, instruments, basic equipment and the necessary personnel to ensure completion of the job. Technically the committee should be able to use external consultants when necessary. These external consultants should act as facilitators.

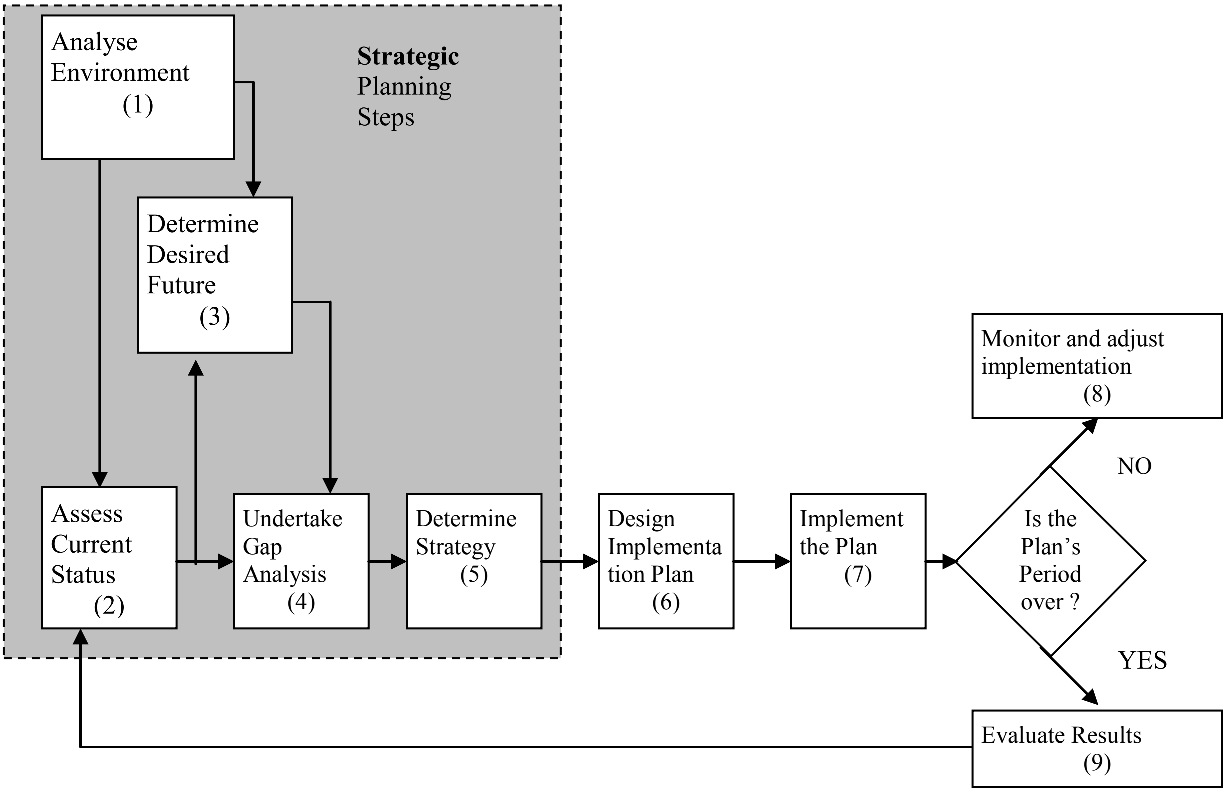
Process of strategic planning

The strategic planning process i.e. the vision of the organisation's future and its strategy are based on four essential components: analysis of the environment; including opportunities and threats; evaluation of the current status of the organisations (its strengths and weaknesses); assessment of client needs; and the participation of all stakeholders. Strategic planning is a social process of communication, learning and negotiation.

Steps in the process

The various steps involved in the strategic planning process are summarised in Figure 9.2. Each of the steps are discussed in the following sections.

Figure 9.2: Model of strategic planning showing decision-making levels



Source: *Horton et al., 1993*

Step 1: Assess the external environment or environmental scan

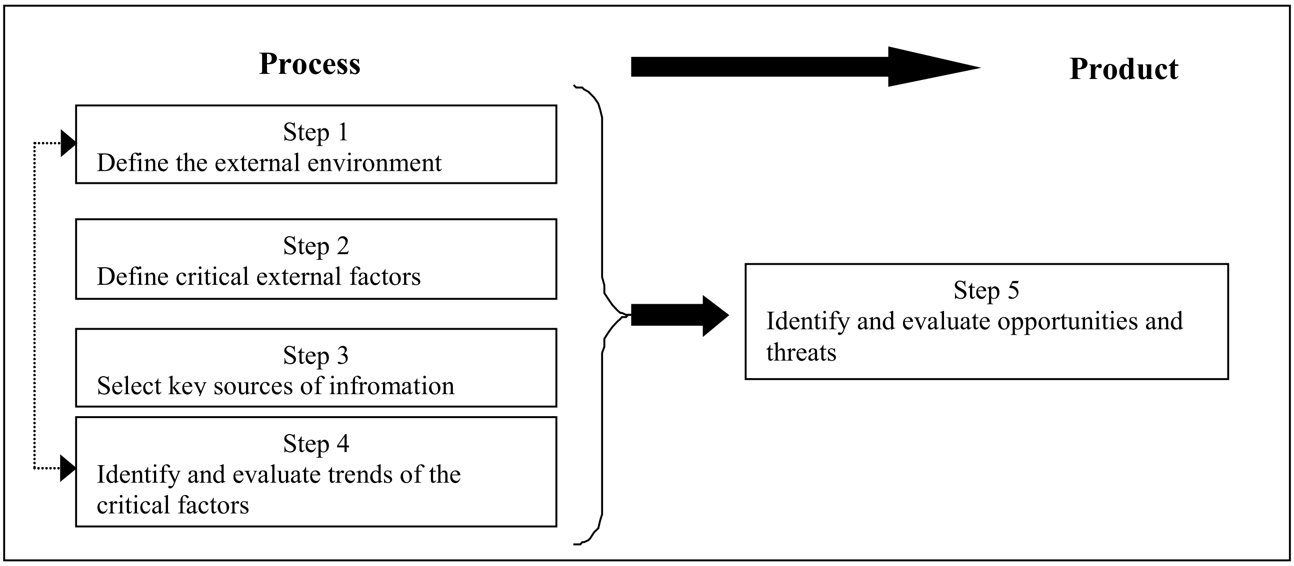
This process also goes through several steps. These steps are summarised in Figure 9.3.

(a) *Identification of relevant external environment*

The relevant external environment can be grouped under two categories: the 'general external environment' and the 'operational external environment'. The general external environment is the macro environment that affects the institution, no matter what sort of research is done. At this level, events are beyond the control of the institution. The socio, cultural, political, economic and technology changes occurring world-wide are examples of this category. The operational external environment is the environment in which and for which the institution develops its activities. It directly influences the institution. Although the operational environment is beyond the direct control of an institution, it has a greater possibility here of exercising some control than in other aspects of the environment.

The main dimensions of the general external environment include socio-cultural dimension, economic dimension, political dimension, legal dimension and the technological dimension. The operational external environment must be analysed primarily in terms of the most relevant actors: regional, national and international clients, users, partners and competitors present and potential and should consider the public, private and non-governmental segments.

Figure 9.3: Steps in external analysis / Environmental Scan



Source: ISNAR 1995

(b) *Define the order of importance of critical external factors*

A 'critical external factor' is any element (force, event, fact or actor) that can directly affect the institution's general performance or performance of some of its activities. Here the group must concentrate on which of the factors identified in the previous step should be chosen as critically important with respect to the general performance of the institute.

(c) *Choose the key sources of information*

At this stage identify the key sources of information with respect to each of the critical factors selected. The sources can be periodicals, documents, government plans, programs and projects, recent books, conference and seminar reports and proceedings, experts / specialist / managers / business people; and academic, political and social leaders.

The objective of this review exercise is to confirm the relevance of each external factors, explore the trends of each external factor and explore whether the combination of each factor and its respective trend translates into an opportunity or a threat for the institution.

(d) *Identify and evaluate the trends of the critical external factors*

Also assess whether the effects/impacts will begin at short-, medium- or long-term.

(e) *Identify and evaluate 'opportunities' and 'threats'*

An 'opportunity' is an element or circumstance that, although not under the direct control of the institute can contribute to any of its most important activities. Any element from the external environment that can somehow benefit should be considered an opportunity. Opportunities must be known to be exploited. Threat is any element that can become a disadvantage/risk/danger for the performance of any of the institutions most important activities. Any element of the external environment that can partially or totally interfere with the institutions general performance or that of any of its activities, should seen as a threat. The threats must be known to be avoided or reduce their impacts.

Each critical factor may represent more than one opportunity or threat, so these should be listed in order of importance according to the potential degree of real or potential impact (low, medium, or high).

A format presented in Table 9.1 may facilitate the external analysis also known as environmental scanning.

Step 2: Organisational analysis

Organisational analysis is an internal assessment of the institution where the internal strengths and weaknesses of the institution/program should be identified and evaluated mainly in relation to the opportunities and threats identified in the relative external environment.

With respect to the organisation this involves assessing:

- The interests of scientists, managers, and members of the governing body;
- The culture of the organisation;
- Mission and guiding values; and
- Past achievements, capabilities and limitations.

Also assess the effectiveness of the current strategy in terms of present goals and priorities, specifically.

- Relevance of goals and priorities to client needs and the interests of external stakeholders;
- Consistency between the present strategy and the organisations mission and guiding values; and
- Appropriateness of the current strategy in light of the organisation's resources and capabilities.

In terms of methodology for organisational analysis:

1. Identify the aspects to be analysed;
2. Define the information needed;
3. Decide who will gather the information;
4. Determine how the information will be gathered and processed; and
5. Plan how to present the results and conclusion.

The organisational analysis is carried out in 5 steps, which are summarised in Figure 9.4 and discussed below

(a) Identify the relevant organisational inputs

All financial, physical and human resources used in the institutions operations, whether in management, research or technology transfer can be defined as organisational inputs.

The analysis of relevant inputs includes inputs that are currently available as well as those that are not. They can be classified into two broad groups: indispensable and complementary. The indispensable organisational inputs are those which are essential for achieving the objectives. Complementary inputs might constitute to an 'ideal situation' that is out of the institutions budget range. Once the organisational inputs have been identified, the next step is to assess their quality.

(b) Identify relevant organisational process

A relevant organisational process can be defined as an action or set of action through which the institution transform its inputs into outputs (knowledge or technology). In the analysis of these processes, special attention should be given to decision-making in its different stages.

Examples of organisational processes in an agricultural research institution may include

- Choosing, training and stimulating human resources;
- Obtaining and managing funds – acquisition and management of financial resources;
- Quality control – aspects such as performance, concern for environment, and cost control are also considered;
- Planning, monitoring and evaluation of research activities; and
- Needs assessment and responsiveness to clients.

The most important aspects to be included within each process should be related to supervision, execution, functioning and possible improvement.

Key questions for the analysis of an organisational process.

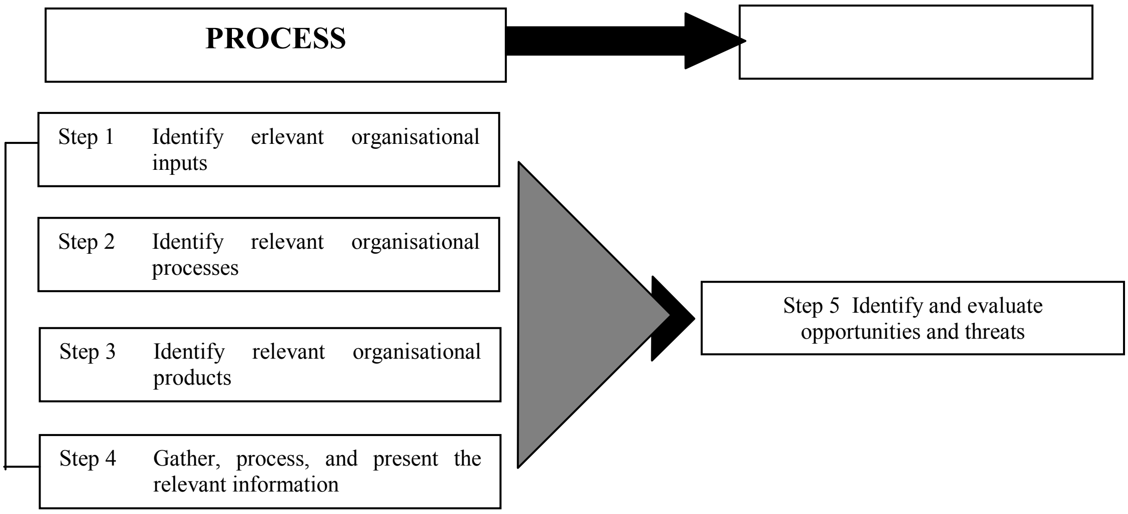
- Who supervises the process?
- Who carries out the process?
- How well does the process work?
- How could the process be improved?

Table 9.1: Chart to facilitate retrospective external analysis

Main dimensions of the relevant external environment	Critical factors in order of importance	Sources of information	Explanation/ justification	Trends	Impacts			Opportunities	Threats
					S	M	L		
► **General external environment**									
• Socio-cultural dimensions									
• Economic dimensions									
• Political dimensions									
• Legal dimensions									
• Technological dimensions									
► **Operational external environment**									
• Clients									
• Users									
• Partners									
• Competitors									

S = Short-term; M = Medium-term; L = Long-term
Source: Adapted from ISNAR (1995)

Figure 9.4: Steps of organisational analysis



(c) Identify relevant organisational products

The last step in the organisational analysis is the analysis of the products generated by the institution.

This should include products from the scientific program as well as application of technologies already tested elsewhere.

Examples of the products of agricultural research are presented in **Box** 9.1.

Box 9.1: Examples of Agricultural Research Products

- Finished products:
  - Seeds and improved varieties;
  - Animal breads of specific characteristics;
  - Machinery and equipment; and
  - Chemical and organic inputs.
- Products related to knowledge on:
  - Management of crops and production systems;
  - Animal management and sanitary control; and
  - Natural resource management and preservation.
- Intermediate products that constitute to scientific program
  - Identification of sources of disease assistance
  - Development of new methods or processes; and
  - Maintenance and classification of germplasm

(d) Gather, process and present relevant information

Various committees could be formed to facilitate the process - Institution expert committee can be formed to assist and co-ordinate the process. The main function of this committee is to identify information needs for the analysis.

- Gather data;
- Analyse the information; and
- Present the results

It should be noted that organisational analysis is fundamentally an internal exercise in which all relevant parties should participate. A synthesis of the results must be distributed and discussed widely.

(e) Identify and evaluate strengths and weaknesses

Strength refers to the characteristics of the inputs, processes and products that allow the institution to take advantage of the opportunities or that protect it from the threats coming from the context.

In reality organisational strengths are derived mainly from decision-making at a management level, in terms of the allocation of resources. A proper allocation of internal resources allows the institution to in interact most effectively with the market.

The organisational strengths can be analysed in terms of what the institution can do that others cannot. Organisational strengths are strengths only in comparison with the market and possible competitors, e.g., highly qualified and specialised staff.

When gathering information about the strengths of the institution it is useful to:

- Distinguish between the strengths that support the institution.
- Permit it to take advantage of opportunities; and
- Distinguish strengths that defend the institution from threats.

Similarly, it is necessary to distinguish the strength that comes from the availability of inputs, from the structure of the processes, or from the characteristics of the products.

Organisational weaknesses refer to all the characteristics of inputs, processes, and products that do not help the institution to make use of the opportunities or that do not protect it from threats coming from the external environment. The policy of reducing weaknesses has two goals.

- Maintaining the institutions position in the market which can be the short-term objective.
- Stimulating institutional development and growth, which can be a long term objective.

Organisational weaknesses should be classified as those that do not support the institutions to use opportunities or those that do not protect it from threats. The other dimension for the classification of weaknesses is related to organisational inputs, processes and products.

Step 3: Determine the desired future state of the organisation

Basic questions to be address here are:

- What should the organisation look like in 5 - 10 years from now?
- What products or services are to be produced and for what clients?

Step 4: Gap analysis

Gap analysis deals with the difference between the current situation and the desired scenario - gives a measure of needed changes.

Gap analysis facilitates the definition of a desired future state of the institution and the action to be taken to move toward it. Gap analysis should answer the questions to what changes should be made in the inputs and internal processes to be able to offer the product and/or services that the clientele needs in the next five to ten years? Gaps are the differences between:

- Present and desired product (product gap);
- Existing inputs and the ones needed (input gap); and
- The current processes and the ones to be introduced (process gap).

Gaps can occur at different levels of the research institutions, programs or project. Gaps should also be identified at different administrative levels such as experimental stations, regional centres, central offices, etc.

The gap between the organisations current situation and its future desired status is analysed in terms of resources, capabilities organisation and structure and guiding values. This process should lead to the development of a future strategy which includes

- A clear definition of the organisation's clients;
- Mission and guiding values;
- Goals, major strategic directions and issues and priorities; and
- Resources needed to implement the chosen course of action.

Although for the sake of clarity, environmental analysis, organisational analysis and gap analysis are presented separately, they can be carried out as one exercise in which the information flows throughout all steps.

Step 5: Determine the strategy to go from the present to the desired future state of the organisation

This should spell out activities and resources and the way to combine them.

Step 6: Formulate an implementation plan that operationalise the strategy

This should detail needed organisational changes together with the resources required and their timing. It should also specify the outputs or results expected and their timing. This aspect is critical for monitoring and evaluation. It is also critical to define performance measures.

Step 7: Implement the plan

During implementation several issues need to be addressed. These include prioritisation of action, accountability, and integration with existing plans and processes. The key challenge is making the changes and decisions a permanent part of the organisations functioning.

Steps 8 and 9: Monitor, adjust and evaluate plan

Various aspects related to implementation, monitoring and evaluation are discussed elsewhere in this sourcebook. Steps 1 - 5 are included in the strategic planning process.

The objective of the overall strategic planning exercise is related to sustainability and development. The first target is reducing or if possible eliminating the risks to the institutions sustainability or survival. Future developments in the institutional environment cannot be forecasted with certainty. So the decisions must be more cautious, aimed at improving the institution's flexibility to modifications in the demands for products or services offered. There may be a possibility that the institution alters its business environment through innovations. Such innovations could be a new product, process input or a combination of these. The uncertainty in the case of innovations is greater.

In agricultural research institutions, the main restriction for closing gaps is lack of human and financial resources. If both types of resources are relatively scarce, the institution should concentrate its efforts on the first category of gaps, those that jeopardise the institutional sustainability. If resources are relatively sufficient -find a strategy that combines activities covering the three categories.

Conditions for success

Several conditions may facilitate the development and successful implementation of a strategic plan.

These include:

- A compelling reason for undertaking strategic planning;
- Support from key decision makers and leaders;
- Strategic planning training for employees;
- A person to facilitate the process;
- Communication among key stakeholders;

- A tailoring of the strategic planning process to the organisation.;
- An action plan that requires people to accept responsibility;
- A mechanism for recalling the benefits of the process when things get tough;
- A clear interpretation of the strategic plan in day-to-day operations; and
- Integration of the strategic plan with all affected organisations - common organisations with common goals.

Therefore, it is important to ensure that most of these conditions exist if not, should be develop during the strategic planning process in order to make it a success.

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components of a strategic plan

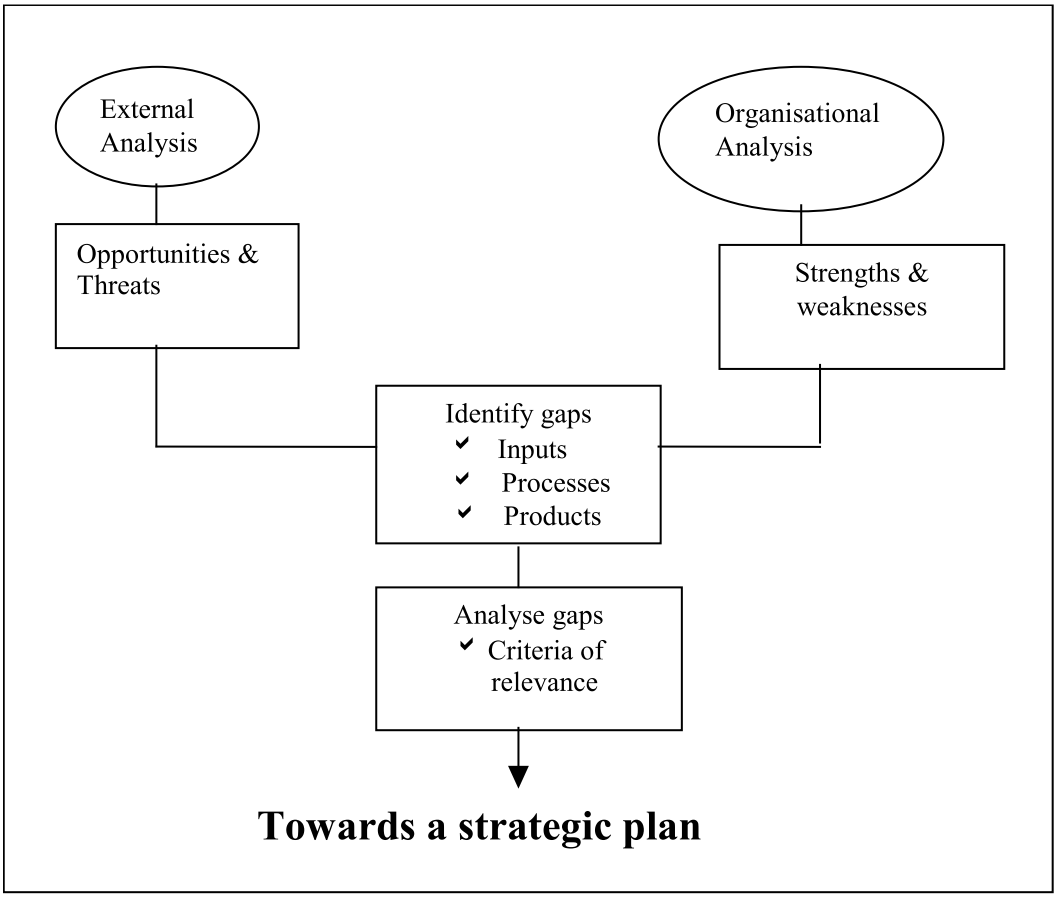
Introduction

The overall objective of the environmental analysis (environmental scan) organisational analysis (situational audit) and the gap analysis is to construct a strategic plan. These are processes for generating information (see Figure 10.1). Once the analysis is completed, there are 5 steps involved in formulating a strategic plan as show in Figure 10.2.

1. Formulating the mission;
2. Formulating the objectives;
3. Formulating the policies;
4. Validating the mission, objectives and policies;
5. Formulating strategies;

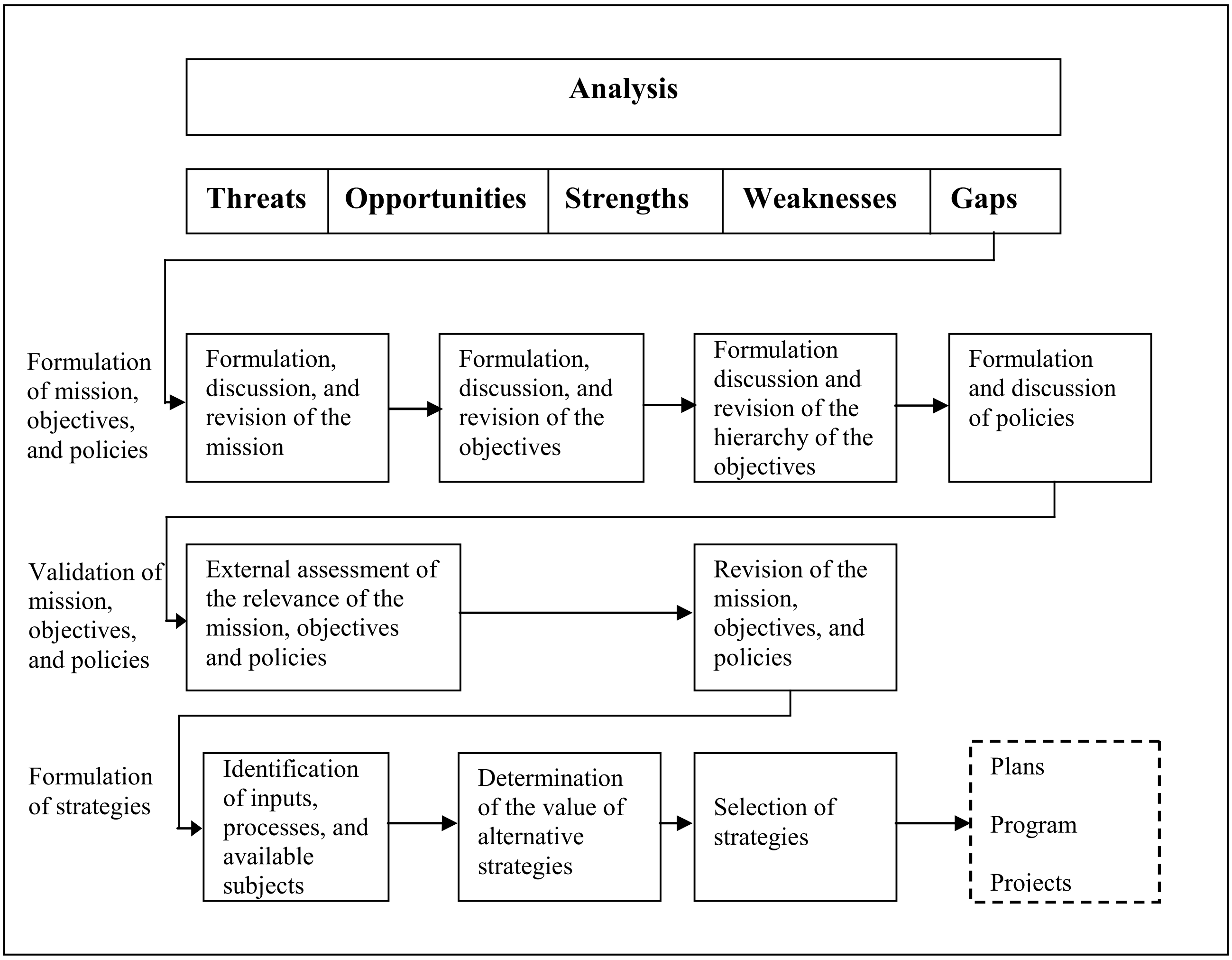
The various components of a strategic plan are discussed in this chapter.

Figure 10.1: Process of Generating Information to Formulate a Strategic Plan



Source: ISNAR (1995)

Figure 10.2: Steps for the formulation of the mission, objectives, policies and strategies



Mission

A mission statement is a short description of the main purpose, the final goal and its most comprehensive justification. It should include information that will guide the organisational behaviour and the direction that the institution takes. A well-formulated mission communicates values that motivate and guide. It is important to formulate clearly, precisely and explicitly its mission and to make it known within and outside the organisation. A mission statement provides motivation, general direction, image and a philosophy that serves as a guide to develop the organisation.

Purpose of mission

In its widest sense the mission is the purpose of an institution. A mission statement is considered essential because of the following reasons.

- It communicates clearly the purpose of an organisation - avoiding contradictions and conflict.
- It gives logical basis for allocation resources - both human and financial.
- It gives a reference for formulating objectives, policies and strategies.
- It gives a basic sense of direction.
- It is a guide for decision making.
- It is a unifying force.
- It builds commitment.
- It reduces control and restricts options.

Characteristics of an effective mission

1. The mission statement is clear and understandable to all personnel, including rank and file employees.
2. The mission statement is brief enough for most people to keep it in mind. This means one hundred words or less, which is possible.
3. The mission statement clearly specifies what business the organisation is in. This includes a clear statement about:
   - What customer or client needs the organisation is attempting to fill, not what products or services are offered;
   - Who the organisation's primary customers or clients are;
   - How the organisation plans to go about its business, that is, what its primary technologies are; and
   - Why the organisation exists, the overriding purpose that the organisation is trying to serve and its transcendental goals.
4. The mission statement should identify the forces that drive the organisation's strategic vision.
5. The mission statement should reflect the distinctive competence of the organisation. Distinguishes its institution from all the other organisations in the same field of activities.
6. The mission statement should be broad enough to allow flexibility in implementation but not broad enough to permit a lack of focus.
7. The mission statement should serve as a template and be the means by which managers and others in the organisation can make decisions.
8. The mission statement must reflect the values, beliefs, and philosophy of operation of the organisation.
9. The mission statement should be achievable i.e. it should be realistic enough for organisation members to buy into it.
10. The wording of the mission statement should help to serve as an energy source and rallying point for the organisation.
11. Specific enough to exclude certain activities and comprehensive enough to allow creative growth.

Box 10.1: A mission statement should include

* Basic purpose;
* Product and services;
* Clients;
* Value, philosophy and technology;
* Self-image;
* Expression of distinct competence; and
* Source of inspiration

Within the agricultural research organisation mission can be defined at the institute, centre and program levels. A mission statement should consist of two parts.

(a) An opening paragraph which generally includes the purpose, the product and a clients of the organisation; and
(b) The 'body' of the statement, which expands on the opening.

Examples of Mission statements are presented Box 10.2.

Box 10.2: Example Mission Statement

A general mission statement for agricultural research organisation can be

> *"To generate, adopt, promote and transfer of scientific knowledge for sustainable development of agriculture for the benefit of the society".*
>
> *"to contribute to improve the quality of knowledge and techniques that integrate the objectives of competition, equity and sustainability, and scientific capacity, as a strategy to improve the relevance and ability for research to respond to the development needs of the rational agricultural sector".*

Microsoft's Mission Statement

'Microsoft's mission has been "to create software for the personal computer that empowers and enriches people in the work place, at school and at home".

Formulating objectives

In the broadest sense, an objective is the future state, situation or result that somebody wants to achieve. Objectives are key strategic initiatives that direct organisational efforts toward the accomplishment of goals. In the strategic planning process it is recommended that the objectives be defined in association with decision-making levels and the time horizon for achieving them.

Objectives can be divided into three categories: institutional objectives, functional objectives, and operational objectives.

Institutional objectives, These are based on institution's mission statement and external, organisational and gap analysis; strategic in nature; long-term, rather inflexible and qualitative. These should serve as the reference for formulating institutional policies and strategies and functional objectives. Generally formulated by top management

Functional objectives, These are based on institutional objectives; referring to tactical level; medium-term, more flexible, quantitative and probabilistic. They should serve as a reference for the formulation of the functional norms and tactics and of the operational objectives. functional objectives should be formulated by middle management.

Operational objectives, These are derived from functional objectives; referring to the operational level, short-term, highly flexible, quantitative and deterministic. They should serve as a reference for formulating the operational directives and activities in the various administrative and technical units. Operational objective should be formulated by line management.

The institutional objectives should be included in the strategic plan; the functional objectives in the tactical plan and the operational objectives in the operational plan. The objectives of all three categories should be communicated to all employees, every year.

Clearly formulated objectives provide direction; allow synergy for development, guide planning, monitoring and evaluation and support both resource allocation and design of positions and their respective functions.

Objective setting

When developing objectives, make certain that they communicate, indicate, and provide those items outlined below:

Communicate

- Key items from strategic database;
- Major decisions/directions;
- Expected results of decisions;
- Specific actions required and accountability; and
- Financial implications/requirements.

Indicate

- Informal requirements; and

- Unresolved issues

Provide

- Guidance from decision to action;
- Focus;
- Basis for review, control, and planning

Criteria for objective-setting

Essential

1. Feasible;
2. Suitable;
3. Acceptable;
4. Achievable; and
5. Measurable

Desirable

1. Adaptive; and
2. Firm determination

Formulating policies

Policies are inputs towards achieving an objective. A policy is not an action, but a guide to decision and behaviour intended to stimulate, support or guide actions in a desired direction toward an objective. Well formulated policies contribute several ways to the management of an institution. Some policies may set limits, boundaries and restrictions to different actions. Some policies clarify what is expected from different groups of staff: improve co-ordination as well as delegation of authority.

Basic characteristics of an effective policy are:

- Δ Flexibility to support the institution's adjustment to changing environment;
- Δ 'Scope' to involve relevant aspects that allow the institution to move towards its desired goals;
- Δ Co-ordination to concentrate efforts around related activities; and
- Δ Ethics: so the actors of the institution can carry out their activities according to ethical and moral values.

Types of policies

Policies can be classified according to their scope, the way of making them known, their origin, their objectives, the decision making level at which they are formulated and their nature.

- As for their 'scope' policies are classified as 'general' and 'specific'.
- As for the way of making them known, policies are classified as 'explicit' (written and made known widely and publicly) and 'implicit' (not written and for restricted communication).
- As for their origin policies are classified as 'established' when they are derived from the mission and objectives; 'solicited' when they are derived from claims made by certain groups, and 'imposed' when they are derived from external pressure.
- As for their objectives policies are classified as 'innovative' - to combine strengths and opportunities; for 'maintenance' - to use the inner strengths against external threats; for 'survival' - to avoid confronting weaknesses with external threats.
- As for levels of decision making - where policies are formulated and managed 'strategic', 'functional' and 'operational'.
- As for their nature, policies can be classified as institutional and technological.

Policies are usually formulated by top management of an organisation but should be made known to and discussed by all staff. Formulating policies is an activity with much exchange and knowledge, and of group creativity requiring maximum consensus. At the different decision making levels, management should formulate strategic tactical and operational policies. The formulation and classification by hierarchy of the policies in each of the levels should follow and approach similar to that for formulating and classifying objectives. In an organisation that produces knowledge, such as the agricultural research institutions, the institutional, program and project - level policies should be consistent.

Validating the mission, objectives and policies

This step is aimed at consensus building among the stakeholders. According to Paez *et al*. (1991) there are three steps to validate the mission, objectives and policies.

1. Identify a group of organisations or individuals representing beneficiaries, users, clients, partners and donors.
2. Ask them to fill out a questionnaire containing the definition of the mission objectives and policies. Request them to appraise the relevance of each and suggest changes. Clearly explain the reason(s) for the survey in an introduction.
3. Review the mission, objectives and policies based on the information generated through step 2. Sometimes a 'stakeholders' workshop can be convened to achieve the same purpose.

Formulating strategies

A strategy is defined as a logical combination of actors, factors and actions selected among other alternative combinations to achieve a certain objective in a specific context. This definition has three implications:

Δ To achieve a certain objective, there are many possible combinations and therefore alternative strategies.
Δ In order for the same objective to be achieved by different institutions or similar objectives in different locations the strategies will be different.
Δ Considering that there are many possible combinations of actors, factors and actions to achieve one objective, the selection of a strategy is the result of a political decision.

Box 10.3: Policies and Strategies

- Policies are *general* they express *desires*, and give focus to many objectives but strategies are *specific*, they express *tasks* and give focus to few objectives.
- Strategies consists of sequence of steps, but policies are set of decisions.
- Policies emphasise the internal environment of the organisation whereas strategies emphasise external environment (the condition) in which inputs and processes (actors, factors and action) will be combined to achieve an objective.

The desired objectives are the main reference point for formulating strategies. The success or failure of a strategy depends on the clarity and precision of the objective. Clarity is needed in

- Defining the relevant context in which the objective will be achieved;
- Identifying the strategic actors to achieve the objectives;
- Identifying the critical factors for achieving the objectives;
- Defining the actions with greatest potential for supporting the achievement of the objective; and
- Designing the logical steps of the strategy that will combine the actors, factors and actions to achieve the objective in its corresponding context.

Six steps are useful for the formulation of a strategy:

1. What is the objective to be achieved? (the objective is the 'product' aimed for with the strategy).
2. What is the 'context' in which the objectives must be achieved? (Context offers key information on the relevant actors, factors and actions in the formulation of strategy).
3. Who are the relevant 'actors' to achieve the objective: and
    - Both internal and external who can affect positively or negatively
    - The identified actors are important 'inputs' for formulating the strategy
4. What are the strategic 'factors' for achieving the objective. Key factors are relevant 'inputs'. Once again consider both internal and external factors.
5. What are the important 'actions' that should be organised in order to achieve the objective.
    - Short-, medium- and long-term

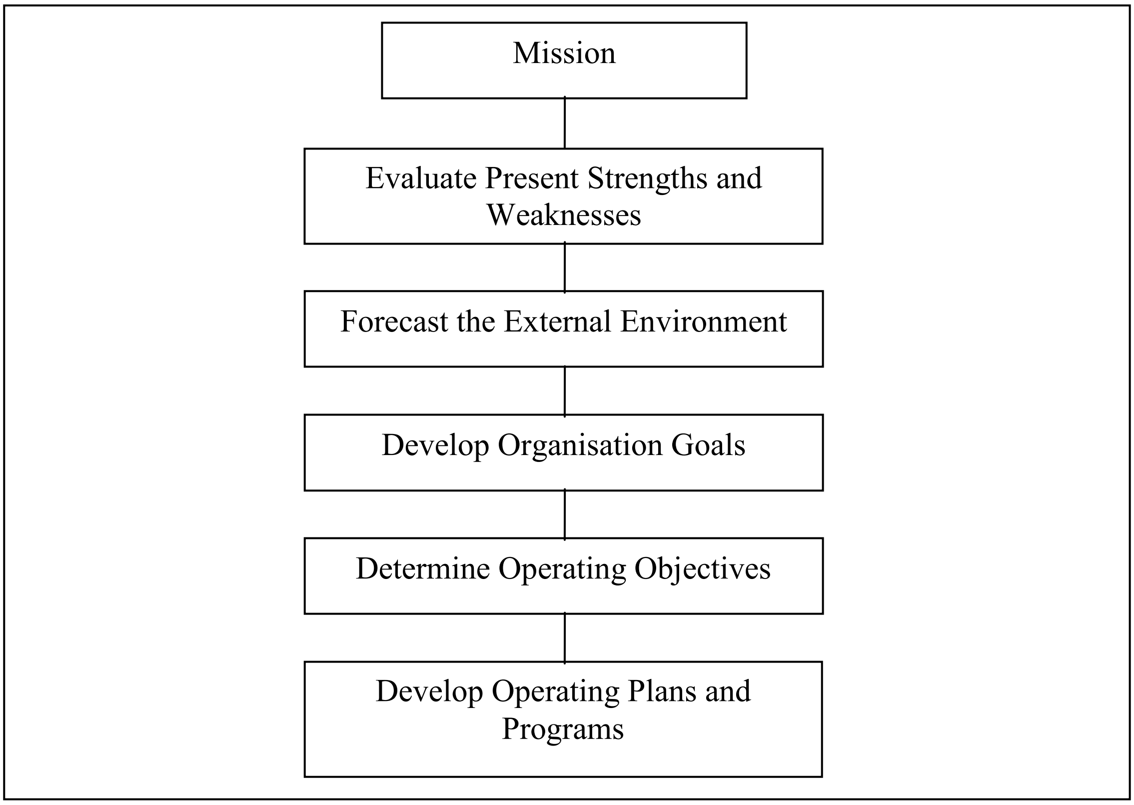
These actions are the 'processes' that the strategy uses to combine actors and factors in logical steps toward an objective.

6. What are the 'logical steps' of the strategy, and in what order, to assure the best combination of actors, factors and action to achieve the objectives.

   Designing the logical order of the steps is fundamental in the formulation of the strategy.

To conclude once again the steps involved in the strategic planning sequences are summarised in Figure 10.3

Figure 10.3: Strategic Planning Sequence



This chapter and the previous chapter dealt with the various aspects of strategic planning process. The strategic planning is long term in nature and requires considerable amount of resources. However, needs to be revised periodically depending on the changes in the external environment which may affect the client needs and performance of the institution.

Another strategic planning process which is becoming increasingly useful in a dynamic, complex, and turbulent environment is Scenario Planning. This process is discussed in the next chapter.

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Scenario Planning

Introduction

In a fast moving world, with complex business environment scenario planning is a powerful tool for anticipating and managing change. The business environment is rapidly changing, complex and unpredictable (also called turbulent or "raplex" environment). The new generation of managers is facing the task of creating a balance between stability necessary to allow development of strategic planning and decision process and instability that allows continuous change and adaptation to dynamic environment (Hilt, et al 1998:24). Companies that enjoy enduring success have core values and core purpose that remain fixed while their business strategies and practices endlessly adapt to a changing world (Collin and Porras, 1996: 65). Scenario planning is a tool which has been successfully used to handle the raplex environment. Scenario planning technique is applicable to virtually any situation in which a decision maker would like to imagine how the future might unfold. In this chapter the various steps involved in scenario planning are discussed briefly. It is worth mentioning that scenario planning can be considered as part of or extension of conventional strategic planning.

What is scenario planning

There is strong evidence that the combination of *robust* business concepts and *responsive* organisation is the key to performance in a rapidly changing and complex environment that almost every company/institution today faces. Lindgren and Bandhold (2003) also concluded that robustness and responsiveness are strongly driven by three competencies namely "thinking", "playing", and "gardening" ie. lead in mind, (thinking) lead in experimenting and lead in culture. The various aspects considered in thinking, playing and gardening are summarised in Table 11.1

Table 11.1: Attributes Associated with "Thinking", "Playing" and "Gardening

Thinking (Lead in mind)	**Playing (Lead in Experience)**	**Gardening (designing) (Lead in culture) organisational pre-requisite**
• Arena analysis • Alternative thinking • Options scanning • Vision – mission • Participation • Extensiveness	• Strategic Experimentation • Exploring the future through creating it • Entrepreneurship – Visionary – Proactive – Innovation focus – Adaptiveness – Action orientation	• Cultural control • Strategic conversation • Team spirit • Non-political culture • Rituals

Source: Lindgren and Bandhold (2003)

The thinking practices have the highest impact on robustness and responsiveness, thus on organisational performance. They are the strategy related practices that fall under the label 'scenario planning' practices. Scenario planning is a set of processes for improving the quality of the educated guesses and also for deciding what the implications are, and when to gamble (Lindgren and Bandhold, 2003). It is a disciplined method for imaging possible futures (Shoemaker, 1995). Scenario planning is a discipline for rediscovering the original entrepreneurial power of creative foresight in context of accelerated change, greater complexity and genuine uncertainty (Pierre Wack, 1984)

Scenario planning is more closely related to strategic planning and has to be seen in the context of strategic planning. The characteristics of the scenario planning compared with the traditional planning are summarised in Table 11.2

Table 11.2: Characteristics of traditional planning compared with Scenario Planning approach

	Traditional Planning	Scenario Planning
• Perspective	Partial, Everything else being equal	Overall, nothing else being equal
• Variables	Quantitative, objective, known	Qualitative, not necessarily quantitative, subjective, known or hidden
• Relationship	Statistical, stable structures	Dynamic, emerging structure
• Explanation	The past explains the present	The future is the raison of the present
• Picture of future	Simple and certain	Multiple and uncertain
• Method	Deterministic and quantitative models (economic, mathematical)	Intention analysis, qualitative and stochastic models (cross impact and systems analysis
• Attitude to the future	Passive or adaptive (the future will be)	Active and creative (the future is created)

Source: Lindgren and Bandhold (2003)

Scenario planning differs from the other planning methods such as contingency planning, sensitivity analysis and computer simulations in a number of ways (Schoemaker 1995). Contingency planning examines only one uncertainty. It presents the base case and an exception or contingency, whereas scenarios explore the joint impact of various uncertainties which stand side by side as equals.

Sensitivity analysis examines the effect of a change in one variable keeping all other variables constant. Moving one variable at a time makes sense for small changes. However, if the change is much larger, then other variables will not stay constant. Scenarios on the other hand, change several variables at a time, without keeping others constant. They try to capture new states that will develop after major shocks or deviations in key variables.

Scenarios are more than just the output of a complex simulation model. Instead they attempt to interpret such output by identifying patterns and clusters among a million of possible outcomes a computer simulation can generate. They often include aspects/elements that were not or cannot be formally modeled such as value shifts, or new regulations. Hence, scenarios go beyond objective analyses to include subjective interpretations. By defining basic trends and uncertainties, a manager can construct a series of scenarios that will help to compensate for usual errors in decision making.

A scenario is neither a forecast (unsurprising projection of the present) nor a vision (a desired future). Both forecast and vision trend to conceal risk, scenarios, in contrast makes risk management possible. Forecasting is at the "certain" end of the spectrum and scenarios at the "uncertain" end of the spectrum. The difference between forecasting and scenarios are illustrated in Table 11.3 and Figure 11.1. However, it is worth nothing that in scenario planning forecasts could be used as inputs for scenario development. The term scenario is defined differently by different practitioners. A sample of definitions from the various literature are presented in Table 11.3. Unlike traditional forecasting or market research, scenarios present alternative images instead of extrapolating current trends from the present. Scenarios also embrace qualitative perspectives and the potential for sharp discontinuities that econometric models exclude. Ultimately, the results of scenario planning are not a more accurate picture of tomorrow but better thinking and an on-going strategic conversation about the future.

Box 11.1: What is a Scenario?

"An internally consistent view of what the future might turn out to be – not a forecast, but one possible future outcome" (Michael Porter, 1985)

"That part of the strategic planning which relates to the tools and technologies for managing uncertainties of the future. (Gill Ringland, 1998)

"A tool (for) ordering one's perceptions about alternative future environments in which one's decision might be played outright (Peter Schwatz, 1991)

"A disciplined method for imaging possible futures in which organisational decisions may be played out"

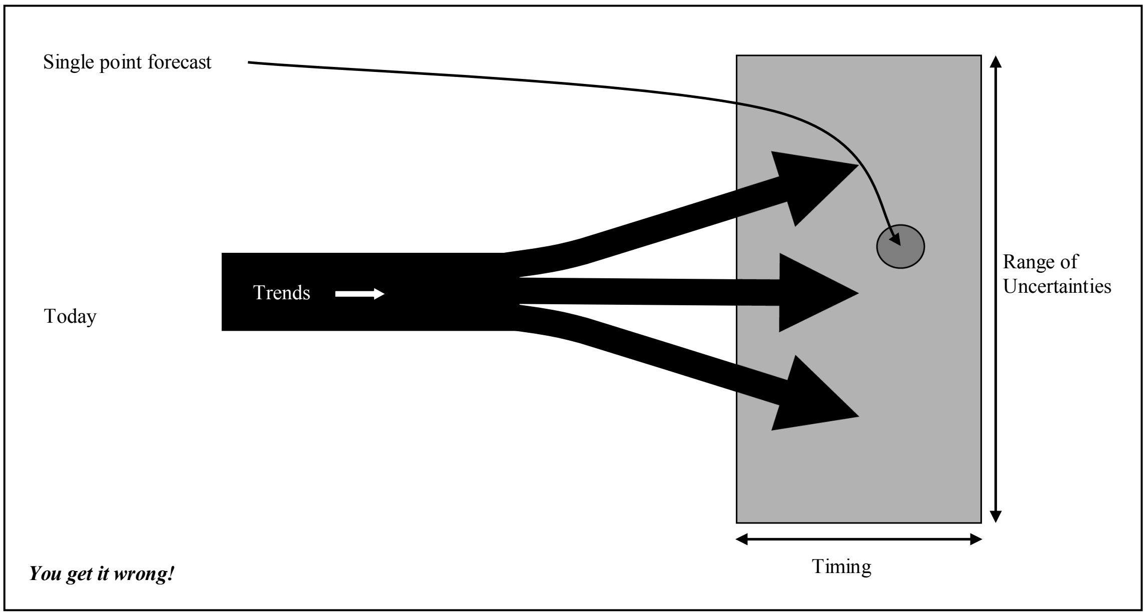
(Paul Schoemaker, 1995)

Table 11.3: Differences between scenarios, forecasts and vision

Scenarios	Forecasts	Visions
• Possible, plausible futures • Uncertainty based • Illustrate risks • Qualitative or quantitative • Needed to know what we decide • Rarely used • Strong in medium to long-term perspective	• Probable futures • Based on certain relations • Hide risk • Quantitative • Needed to dare to decide • Daily used • Strong in short term perspective and low degree of uncertainty	• Desired future • Value based • Hide risk • Usually qualitative • Energising • Relatively often used • Functions as triggers for voluntary change

Source: Lindgren and Bandhold (2003)

Figure 11.1: Scenario planning and forecasting



Source: Ringland 1998

Thus, scenario planning is an effective strategic planning tool for medium to long-term planning under uncertain conditions. It helps us to sharpen up strategies, draw of plans for the unexpected and keep a lookout in the right direction and on the right issues. Through carefully/skillfully crafted scenarios, we can reduce a large amount of uncertainty to a handful of plausible alternative directions that together contain the most relevant uncertainty dimensions.

Scenario planning attempts to capture the richness and range of possibilities, stimulating decision makers to consider changes that they would otherwise ignore. At the same time, it organises those possibilities into narratives that are easier to grasp and use than great volume of data.

Scenario planning offers the greatest benefits under the following circumstances (Schoemaker, 1995).

- Uncertainty is high relative to manager's ability to predict or adjust
- Too many costly surprises have occurred in the past
- The company/organisation does not perceive or generate new opportunities
- The quality of strategic thinking is low
- Competitors are using scenario planning
- There are strong differences in opinion
- The industry/organisation has experienced significant change or is about to
- The organisation wants a common language and framework, without stifling diversity.

Scenario planning can be used for a number of purposes:

1. For planning reasons with an explicit aim to develop practical results.
2. May function both as inspirations for generating idea and as filters through which new ideas and projects can be passed. Here, scenarios function within a 'new business' process.
3. Can also be used for evaluation purposes. For instance to test existing business concepts, strategies or products.
4. Scenarios may also be used for learning or to drive change. Scenario workshops are powerful instruments in the process of challenging existing paradigms and creating shared perspectives on the future.

Scenario planning is an instrument that enables the organisations to integrate discussions of the long and medium term futures with short to medium term strategic planning. In short, the technique is applicable to virtually any situation in which a decision maker would like to imagine how the future might unfold.

Evolution of Scenario Planning

The concept of scenario planning has developed since the Second World War. The modern scenario planning tradition is attributed to Herman Kahn and RAND corporations in the 1950s. In the 1960s the concept was further developed by Hudson institute and in the 1970s promoted by Royal Dutch/Shell and the Stanford Research Institute (SRI) International. During this period the scenario planning became much more closely linked to strategy.

The scenario planning era during the 1970s was short lived. The recession following the oil crisis in the mid to late 1970s forced corporations to cut corporate staff. Oversimplified scenarios came in for criticisms, often justifiably. This, along with long standing habits of rigid long term planning, and the failure to distinguish scenarios from forecasts, led to corporations to return to more traditional ways of planning.

The planning crisis in the 1980s, however, led to renewed interest in how planning happens, resulting in development of scenario planning methodologies. The turbulence of the 1980s and the renewed interest in managing uncertainty through scenario thinking and planning have caused all major management consultancies to develop their own scenario methodologies. Over the last decade, scenario planning has become more or less a standard tool in most companies and consultancy firm's tool boxes.

In the 1980s organisations were using the following methodologies for scenario planning:

- **Intuitive logic**
  This approach is used by SRI and Shell. The essence of this approach is to find ways of changing mindsets so that managers can anticipate futures and prepare for them. The emphasis is on creating a coherent and credible set of stories of the future as a "wind tunnel" for testing business plans or projects, prompting public debate or increasing coherence.
- **Trend Impact Analysis**
  This approach is concerned with the effects of trends (for instance in markets or population) over a time period. The work done to isolate the important trends may well be similar to that used in what is more generally called scenario planning, but the basic assumption within scenario planning is that we are looking for the unexpected, i.e., what could upset the trends.
- **Cross Impact Analysis**
  This is a tool for analysing the complex systems. It concentrates on the ways in which forces is an organisation, external or internal, may interact to produce bigger than the sum of the parts, or to magnify the effect of one force because of the feed back loops. It has been used successfully where the dominant forces can be identified, and the modeling mechanism can be used to increase management's understanding of the relative importance of various factors.

Types of scenarios

There are also basically three major types of scenarios namely trend based, contrasted and normative. These are very much linked to the methods and approaches used for scenario planning.

The trend based scenarios as the name imply based on trends. These are the most probable scenarios.

In the case of contrasted scenario the decision context can be explored, existing concepts and other factors be evaluated and better decision be made. This is the type that is used in most scenario planning.

The normative scenarios on the other hand are based on vision. Here, one has to have a clear vision of the future, and then develop scenarios to achieve them.

Steps in Scenario Planning

Lindgren and Bandhold (2003) collapsed the whole set of activities involved in the scenario planning into six key steps; namely preparation, tracking, analysing, imaging, deciding and acting. The activities involved in each one of these steps are summarised in Box 11.2.

Box 11.2: Steps and key activities involved in the scenario planning process

Step	Activities Involved
Preparation	• Establish the purpose • Identify the system to be analysed • Identify major stakeholders • Define focal questions • Define time horizon • Define the past and present • History and current situation
Tracking	• Identifying basic trends • Identifying basic drivers • Identify key uncertainties
Analysing	• Verifying trends • Analysing interrelationships between trends • Building scenarios
Imaging	• Developing a vision
Deciding	• Generating strategies • Evaluation of strategy suggestions
Acting	• Putting the strategy into action • Follow up - Monitoring environmental change - Defining process for continuous environment scanning • Early warning

Step 1: Preparation

Scenario planning is all about looking into the future – the future that seems complex, dynamic, uncertain and vague. The preparation for the scenario planning process is very crucial for coming up with meaningful scenarios and subsequent strategies to follow. During the preparation one need to address a number of issues.

Establish the purpose of the scenario planning process.

The main purpose is to create scenarios that can be used as eye opener for future action. The specific purpose may be risk consciousness, new thinking/paradigm shift, business development/concept development, and strategy development/organisational development. The different purposes put different demand on the scenario planning process especially on the skills needed to guide the process and the stakeholder participation.

Identify the system that is to be analysed

Here, one has to take a deeper look at the specific operations/sections that are particularly exposed to a complex environment characterised by rapid changes. Very often, broad views of the future can help to find operations where it is worth making a deeper analysis. An in-depth look into a specific system at a lower organisational level will also give insights that are applicable on a higher level.

Identify the major stakeholders

It is also important to identify the key stakeholders so that their views and perceptions can be affectively incorporated into the process. Ask the basic questions such as

- Who will have an interest in these issues?
- Who will be affected by them?

- Who could influence them?

Identify the current roles of the key stakeholders, interest and power positions and ask how they have changed over time and why? Obvious stakeholders may include customers, partners, suppliers, competitors, employees, shareholders, funding agencies, government and so forth.

Define the focal questions

The focal questions will be determined by the scope of the analysis (in terms of focus product, market, geographical areas and technologies) and the knowledge that would be of greatest value to the organisation far down the road. If we are dealing with an R&D department, the relevant question may be: What kinds of competence are needed to develop tomorrow products? How to attract, keep and develop competence in the organisation?

Time horizon

The time horizon for scenarios must be short enough to create scenarios that are propable, but long enough for us to imagine that important changes with an impact on the future business can take place. The time frame chosen for scenario planning may depend on a number of factors such as the rate of technology change, product life cycle, political elections, competitors' planning horizon and administrative decisions.

Defining the past and present

Although scenario planning processes concern the future, it is important to have a clear picture of the present and the past. It is useful to look at the past and think about what you wish you had known then, that you know now?; and, What has been the past sources of uncertainty? Say for example if one is looking at a ten year scenario, look back over the past 10 years at the changes that have occurred within the organisation, industry, region, country and globally. One would anticipate at least a similar amount of change or even more in the next 10 years. Ideally the entire group i.e. the whole management team will participate in this part of the process. Their unstructured concerns and anxieties are often good starting points for scenario planning.

Some of the basic questions that one would like to address during this stage may be:

- What is the history of the organisation, how has it developed up to now?
- What has been the triggers for change?
- What has been the changes in the competitive landscape, and clientele group?
- What are the main indicators of changes in the landscape?
- What is the attitude to the environment around the organisation and future issues?

All these aspects have a great impact on people's attitudes, openness to change, risk awareness and willingness to try new approaches. This will of course depend the way the process is structured.

History and current situation.

Draw a current situation map of the industry/organisation and clarify underlying conditions. It is important to obtain an overall picture of the current situation and history, that is the underlying conditions of the current status. The current situation map should cover both "the players" and the system one would want to analyse.

The basic questions that need to be addressed are:

- What does the industry look like today?
- What part does your organisation play in it?
- Who want to see change?
- Who are in favour of us?
- What do we say about ourselves?
- What is our competence provision like today?
- What is the worst that can happen?
- What are the issues in the industry/our environment history and the driving forces are critical for the scenario planning process.

It is always important to be very clear about the aims and objectives of the scenario planning process. The way to structure the process and the level of involvement of the stakeholders largely depend on the purpose. It is worth noting most of this information would have been collected during the normal strategic planning process.

Step 2: Tracking

This step is called 'tracking' as it is a matter of tracking changes in the environment that may have an impact on the local questions at hand. Tracking is all about finding trends, drivers and uncertainties.

Driving forces and trends

Long term developments in the arena very largely depend on driving forces in the surrounding world. Therefore, the natural starting point is tracking in the surrounding world. As shown in Box 11.3 the driving forces can be categorised under four broad categories: social dynamics, economic issues, political issues and technological issues. A trend is something that represents a deeper change, not a fad. We start from the present and try to look at changes that can be observed as there has already been a change for sometime in a certain direction.

Box 11.3: Driving Forces

The driving forces at work in any given situation fall roughly into four categories namely, social dynamics, Economic issues, political issues, and technological issues.

- Social Dynamics
  - Quantitative – demographic issues
  - Softer issues – value, lifestyle, demand etc.
- Economic issues
  - Macro economic trends and forces shaping the economy as a whole
  - Micro – economic dynamics and forces at work on or within the organization
- Political issues
  - Electoral
  - Legislative
  - Regularoty
- Technological issues
  - Direct
  - Enabling and
  - Indirect

Source: http://www.wired.com/wired/scenarios/build.html

Identify what political, economic, social and technological legal and industry trends are sure to affect the issues you identified in step one. Briefly also explain each trend including how and why it exerts its influence on your organisation/business. Methods that have been used for trend analysis include workshop approach, media scanning, Delphi, expert panel and focus groups (for detail see Lindgren and Bandhold, 2003).

It may be helpful to list each trend on a chart or so called influence diagram to identify its impacts on your present strategy as positive, negative or uncertain. Discard trends that had a low impact on the focal question as well as those had a very low predictability. Retain trends with high impact and high or medium-high predictability. Every one participating in the process must agree that these trends will continue; any trend on which there is disagreement (within the time frame) belongs to the next step. In identifying driving forces one has to have an outside–in perspective. It is worth noting that these trends are not disconnected. Some trends recur as driving forces or consequences to other trends. A closer examination may reveal that a pattern is emerging. Some of the identified trends may also be difficult to predict.

Identifying key uncertainties

What events whose outcomes are uncertain will significantly affect the issues at hand. Again consider the same categories, identified in the previous step. For each uncertainty determine the possible outcome. Again it is best to keep these outcomes simple, with fewer possibilities at most.

Also identify relationship among these uncertainties since all possible combinations may not be plausible. For example full employment and zero inflation may be ruled out as implausible. Some of these deliberations may also overlap into the next step in the process.

Step 3: Analysis

The primary objectives of this step are:

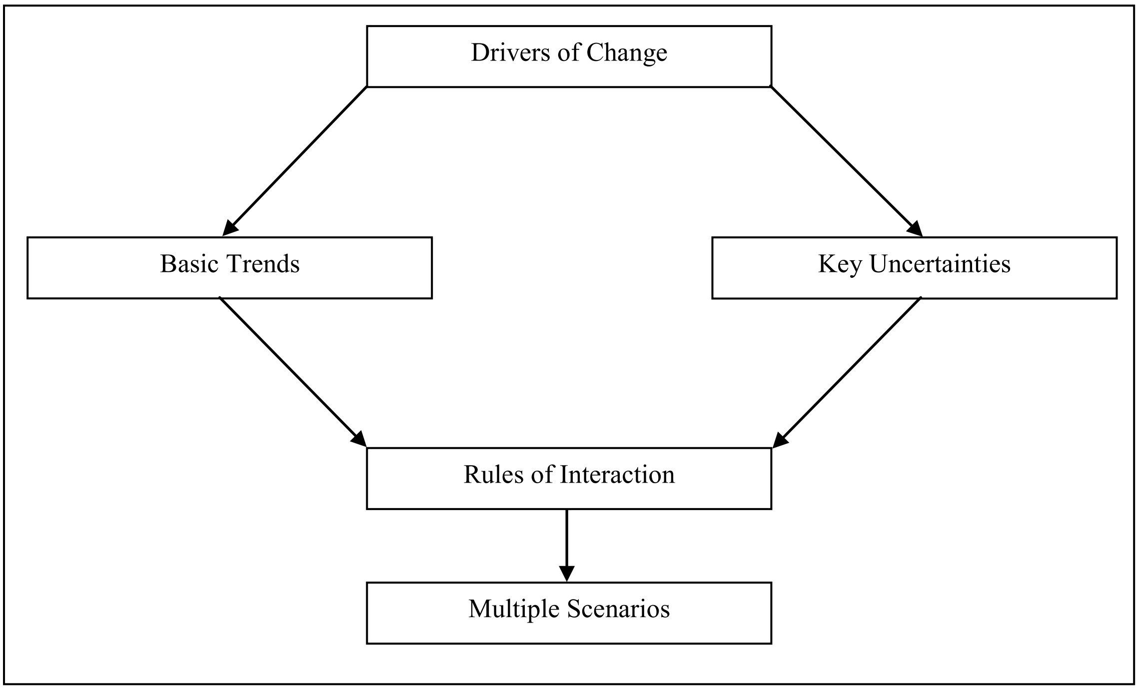
- To identify drivers and consequences in order to understand how the identified trends interact.
- To identify conceivable actions from other players that will affect the system (Player Analysis)
- Verify trends through statistics and other sources. Note that some may be impossible to verify.
- Analysis of the interrelationships between the trends.

All this will give the deeper understanding that is necessary for identifying uncertainties that the scenarios will be based upon. The methods used for analysing interrelationships between trends include cross-impact analysis and causal-loop diagram (for details see Lindgren and Bandhold)

Building Scenarios

The information generated so far will facilitate the construction of initial scenario themes – building scenarios. As discussed earlier scenarios provide a way to handle uncertainties. During the analysis one could have identified a number of trends that are likely to have a great impact on the focal question but are uncertain and not easily predictable. Some are so uncertain and they are called 'wild cards.' These wild cards could of course have a great impact on the focal question, but their predictability is so low that they have no meaningful use as a base for scenario. The building blocks of the various scenarios are summarised in Figure 11.2.

Figure 11.2: Building Blocks for Scenarios



Source: Schoemaker, 1995.

A number of approaches have been used in constructing scenarios (Schoemaker, 1995; Lindgren and Bandhold, 2003). The best practice is to pick-out the top two driving uncertainties and cross them. Four different scenarios will come out. The tricky thing of course is to find two uncertainties that, combined with each other in a scenario, will give us four very different scenarios that can really help us to prepare for an uncertain future. We also need qualitative reasoning in terms of what will happen if this or that occurs? What developments will it lead to? What could bring it to that point? These building blocks for scenarios are presented in Figure 11.2.

Checking for internal constancy

At least there are three tests of internal consistency dealing with the trends, the outcome combinations and the reaction of major stakeholders

- Are the trends compatible with the chosen time frame? If that is the case then remove the trends that do not fit.

- Do the scenarios combine outcomes of uncertainties that indeed go together? Eliminate that pairing or scenario that are not compatible
- Are the major stakeholders placed in positions they do not like and can change?

The stakeholder test is especially critical when building macro scenarios involving, governments, international organisations or strong interest groups.

Developing learning scenarios

From this process of constructing simple scenarios and checking them for consistency some general themes should emerge. The initial scenarios provide future boundaries, but they may be implausible, inconsistent or irrelevant. The goal is to identify themes that are strategically relevant and then organise the possible outcomes and trends around them. Although the trends by definition appear in all scenarios, they can be given more or less different weight or different degree of attention in different scenarios. The developed scenarios should be communicated and approved by all stakeholders for it to be effective.

Identifying research needs

At this stage one may need to do further research to flesh out ones understanding of uncertainties and trends. The learning scenario should help us to find the blind spots.

Often firms/organisations know a lot about their own institution but little beyond the fringes from which the innovation may come. So, one may wish to study new technologies that are not yet in the main stream of the industry under consideration but may be someday. So it is worth doing some research to identify such innovations that are on the pipeline.

Develop quantitative model

After completing the additional research, the team should examine the internal consistencies of the scenarios and assess whether certain interactions should be formalised via a quantitative model.

As managers imagine different outcomes of key uncertainties, they can use formal models to keep from straying into implausible scenarios. The models can also help to quantify the consequences of various scenarios say in terms of price behaviour, growth rates, market share, etc.

Evolve towards decision scenario

Finally, in an interactive process, you must converge toward scenarios that you will eventually use to test your strategies and generate new ideas. Trace back through the various steps to see if the learning scenarios address the real issues identified at the beginning of the exercise.

Ascertain, are these the scenarios that you want to give others in the organisation to spur their creativity or help them appreciate better the up and downside risks in the various strategies? If the answer is yes, then you are done. If not repeat the steps and refocus your scenarios. It is worth noting that half of this judgment is art, half is science.

There are a number of criteria that can be used for judging scenarios

- Scenarios should be relevant - to have impact the scenarios should connect directly with the mental map and concerns of the users.
- Scenarios should be internally consistent and be perceived as such.
- Scenarios should describe generically different futures rather than variations in one theme
- Each scenario should ideally describe an equilibrium state in which the system might exist for some length of time as opposed to be highly transient.

In short, scenarios should cover a wide range of possibilities and highlight competing perspective (within and outside the firm), while focusing on interlinkages and internal logic within each future.

Guidelines for effective scenario communication'

A number of things need to be considered in communicating a strategy. Some of the key considerations are discussed here:

1. A highly descriptive and memorable title.

   Naming a scenario is also important. A memorable title tends to be short, descriptive and distinct. A scenario is a story; by capturing its essence in a title you make the story easy to follow and remember. At this stage, you have constructed the learning scenarios which are tools for research and study, rather than for decision making. The title and themes are focal points around which to develop and test the scenarios

2. A well crafted storyline (skeleton)

   A scenario is not an end state. It is a narrative and vivid description of one possible path to the future. A compelling story line includes answers to the following questions. Who does what? With whom? When? Where? And why? It is important to make sure that the logic of each scenario is completely clear and differentiated from other scenarios

3. A narrative description

   This helps people to grasp and internalise the scenario. Charts, graphs, pictures and other visual materials will help to show its logic. The narrative description does not necessarily have to be long, but essential that they help us to see what future worlds could look like.

4. A table of comparable descriptions

   People who are more analytically oriented, often preferred to have scenarios described in a table that describes the most important differences in logic, end status and so on. Tables can give a good overview of different scenarios, as well as a summary of most important differences between scenarios.

Step 4: Imaging

So far, we have tracked changes in the environment, analysed them and created alternative scenarios. Now, it is time to see as to what can be done to create the desired future. This is where we engage ourselves in what we really want and create a vision. A vision is a positively loaded notion of a desired future. Vision has two components:

- It creates meaning and gives identity, belief, guidance and inspiration
- It is a focused target with clear expectations that hopefully leads to commitment.

A vision is tangible, concrete (highly focused), highly motivating (energising). A vision can be qualitative as well as quantitative. The various components of a vision are presented in Figure 11.3.

Very often the vision statements are developed through a workshop of some sort. (For details, see Lindgren and Bandhold). An ideal vision is normally a barrier breaker, challenging but not totally impossible to reach.

To achieve a shared vision it is necessary to have the participation of all stakeholders, and to disseminate the vision statement in every department and show what it means for that specific workplace and its people, as well as to work intensely to remove obstacles that obstruct movement in the right direction.

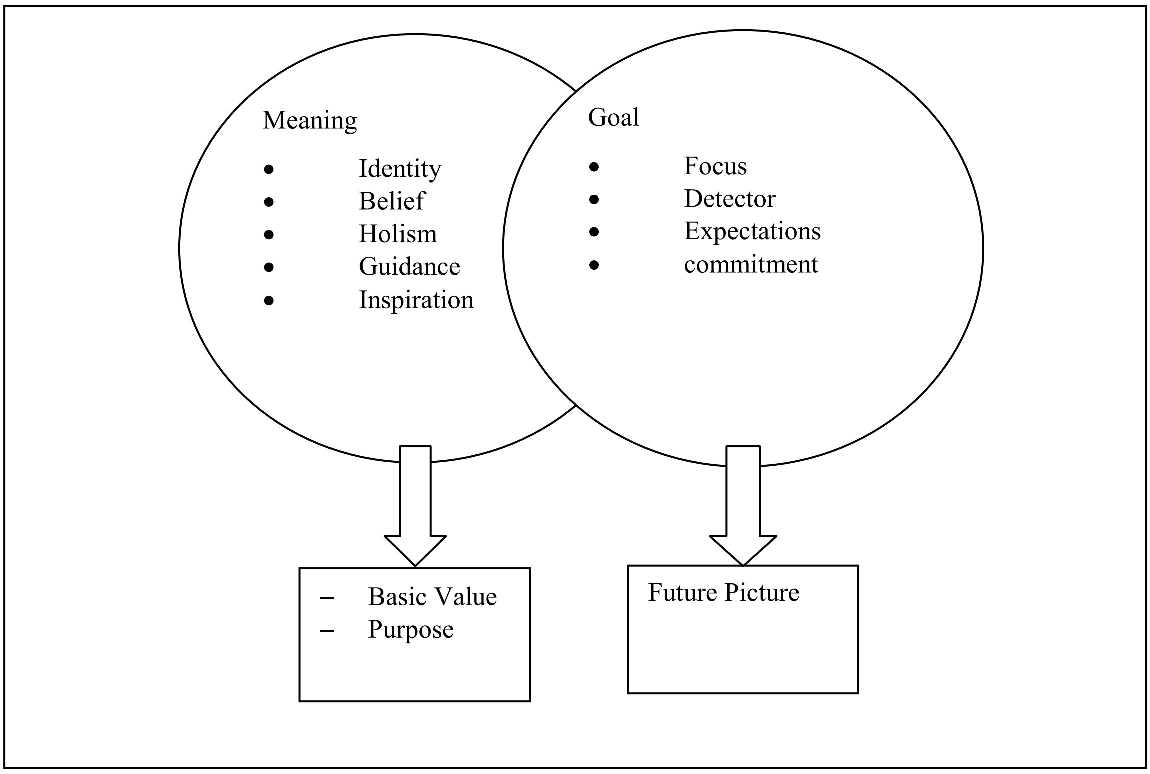
It is important to ensure that the strategies of the company/organisation must support the vision. If not, no one will believe that the vision has any true meaning. Short-term goals and actions in the direction of the vision are also important if the vision is to inspire trust.

Step 5: Deciding

Deciding is the phase where everything is put together in order to determine the future action to be taken. Decision is taken as to what can be done to go in the direction of the vision, taking advantage of the opportunities and avoiding the interests of the future environment. It is important to generate and evaluate strategies that take advantages of the identified changes in the environment.

The first step in this process is generating strategies based on our analysis and vision. Very often trends, scenarios, core competencies and vision are used as inputs for developing strategies. In order to find new strategies we have to abandon top-down thinking and start to think bottom up. The purpose of bottom up strategy is to use the ideas as building blocks that can help us see patterns that no one else has observed before.

Figure 11.3: Components of a vision



Source: Lindgren and Bandhold, 2003

Clustering ideas for generating strategies

Collect all ideas that have come up, whether they came from trends, scenarios, core competencies or visions. Cluster all ideas on a big wall chart and frame the pattern that appears. Try to see new patterns that have not been obvious before. It is important to label theme explicitly.

Looking at clusters may reveal new patterns. You will often not be sure that particular suggestions are the best ones, but many suggestions pointing in one direction can give a hint that there is scope for more ideas of the same kind. It is probably worth while to describe and make a first evaluation of the cluster. Give these clusters names that speak for themselves and a description of a couple of lines.

Evaluation of Strategy suggestions

To evaluate strategies thoroughly can be very time consuming and expensive. At this stage it is important to get a good overview of strategies that may qualify for deeper analysis. Strategies need to be profitable. A profitable strategy tends to be effective in meeting the challenges of the environment, utilise the strengths of the organisation and, finally, help us to go in the desired direction.

A simplest way to evaluate identified strategies is to ask three questions:

- Does the strategy contribute to the desired direction of the organisation (want)?
- Does it utilise present strengths or assets of the organisation (utilise)?
- Does it match the future environment (should)?

Step 6: Acting

The term acting can have two different meanings in a scenario planning process:

- Putting the strategy into action
- Deals with continuous follow up process. This deals with monitoring environmental changes, defining processes for continuous environmental scanning, scenario planning and so on.

The continuous follow up will provide early warning to the management. Early warning is all about early identification of signs of changes, and trend breaks in relation to scenario work that has been carried out. A time line can be very helpful in checking how the probability of the scenario is developing.

Although scenario planning is a powerful tool to handle uncertainties in a complex world, there are also a number of pitfalls in the planning process that need to be kept in mind. These are summarised in Table 11.4

Table 11.4: Common "pitfalls" in scenario planning

Steps in the process	Common Pitfalls
1. PREPARATION	• Unclear purpose • Woolly questions • In appropriate timeframe • A team with a narrow perspective
2. TRACKING	• Identifying trends not based in observed changes • Too narrow a perspective • Too many trends • Not supporting the trends with evidence
3. ANALYSING	• Inability to identify the most relevant uncertainties • Scenarios based on uncertainties that are not really uncertain • Scenarios that are detailed, but not comprehensive • Scenarios that are too general
4. IMAGING	• Pie in the sky • Lack of participation in the vision process • Not communicating the vision enough • Not living the vision
5. DECIDING	• Standard answers to non-standard environment • It feels safe to cling on to old strategies • Not translating long-term strategies into short-term developments • Implementing work patterns that meet future changes too soon
6. ACTING	• Business intelligence only focuses on competitors actions • Low endurance • The information in only used by a few • The future is forgotten

Source: Adapted from Lindgren and Bandhold 2003

In order to assure that all key steps are adequately covered, Peter Schwatz developed a check list (see Box 11.4) which could serve as the best overall guide for scenario planning process.

Box 11.4: Checklist for developing scenario

Step 1: Identifying focal issues or decision
Step 2: Identify key forces in the local environment
Step 3: Identify driving forces
Step 4: Rank driving forces by importance and uncertainty
Step 5: Selecting the scenario logic
Step 6: Fleshing out scenario
Step 7: Identify potential implications
Step 8: Select loading indicators and sign post
Step 9: Develop strategies
Step 10: Implement strategies and follow up

Principles of Scenario Thinking

Lindgren and Bandhold (2003) identified seven principles of scenario thinking. These principles are listed in this section

1. Get yourself a tool box

   Thinking can and has to be improved by techniques, methods and tools. Scenario planning is by nature a multi-disciplinary field, dealing with extremely complex issues. Both qualitative and quantitative methods are necessary at different times. Very simply we can say that scenarios are based on three components where different skills are required.

   - Gathering information: intuition i.e. the ability to see broader picture and powers of observation in detail.
   - Information analysis: Logic i.e. systematic thinking and the ability to see patterns.
   - Modeling the future: creativity

   Techniques and tools are required to facilitate these skills. For a detailed description of the various tools used in scenario planning please see Lindgren and Bandhold (2003)

2. Handle "your brain with care"

   Intuitive scenario thinking is somewhat different from the thinkings that is needed to develop plausible scenarios. To do this, we need to force the brain to think in new directions and challenge old perceptions.

3. Think in "dramas"

   Scenario thinking is based on a view of the world as a drama where each player is dependent on and influences all other players in the scene.

   With "drama" perspective, at each point in time the scenario should give a description of:

   - The events: what s happening (what?)
   - The time when t is happening (when?)
   - The scene where events are taking place (where?)
   - Props: what props are needed and in what way are the actions carried out (how?)
   - Motives: why it is happening (why?)

   Briefly a scenario should answer the questions: Who is doing what? When? How (together with whom?) and why? Thinking in drama like this means seeing the future as a drama or play that has not yet been staged.

4. Thinking in 'future'

   This is the pure essence of scenario thinking and planning. This means putting the future first. Start with what might happen, and from that imagined future, plan for what to do.

5. Thinking in "uncertainties"

   Remember managing the uncertainty is the main task for any managerial process is the core of scenario planning

6. Thinking in 'systems'

   This means thinking in levels and interconnections, independence and dependencies. Make sure that you think from outside-in perspective.

7. Think about strategic moves

   The link from scenario to strategy runs through 'strategic' moves. Note moves are taken by others, but also by your organisation.

Models of carrying out scenario planning.

Basically there are three models to carry out scenario planning. These are the expert model, participation model and the organisational model.

In the case of expert model, one person, or a small group, carry out the task. In the participation model, expert acts as project leader together with a group of people from the organisation. The group owns the results. The experts could come either from inside the organisation or from outside. It is often desirable to have external facilitators and even workshop members, at some stage in the scenario process in order to bring external perspectives into the process.

In the organisational model the expert trains a group of people in the organisation, who then carry out the work. The results in this case will be owned completely by the organisation or the group within it that did the work.

Based on the experience of the various organisations some form of participation model, with a series of seminars and dialogue with key persons is often to be preferred.

Lessons and experiences:

- Although scenario planning is a powerful tool to handle uncertainties in a rapidly changing complex environment. The process is not very widely used. There are a number of reasons for this (Lindgren and Bandhold 2003). These include
  - Uncertainty in conclusions
    Scenario planning does not give one simple answer about the future. Therefore, it does not provide the security that is often required in decision making. Scenario planning is much more demanding then traditional planning
  - Counter intuitive to managerial simplicity
    Another aspect of scenario output is that scenario planning does not accord with the managerial simplicity that says that there is one right answer to every question, that every problem can be divided into three parts, and that each part can be solved separately. Scenario planning is a more holistic or systematic approach to planning than traditional methods.
  - Soft methods and soft answers
    Scenario techniques are usually qualitative, based on reasoning and intuitive patterns recognition, although thorough analysis is often part of the process. The results are often presented in qualitative terms that fit poorly with traditional number oriented culture.
  - Time consuming
    Workshop based methods are times consuming in terms of the number of hours and days participants need to spend to get through results.
- A survey conducted by the conference Board of Europe and reported in Ringland (1998) also indicated that:
  - The length of time spend developing scenarios was always within a single year and mostly less than six months.
  - None of the firms responded mentioned the use of computer models in the process. All discussions collecting information, consultation and workshop within the organisation and the use of a process.

- Most organisations used a mixture of in-house staff and either consultants or academics
- Extensive analysis was not necessarily a pre-requisite for the scenarios. It depends on what questions the organisations are trying to answer.

Finally, it is important to keep in mind that the purpose of scenario planning is not to pinpoint future events, but to highlight large-scale forces that push the future in different directions. It is about making these forces visible, so that if they do happen, the planner will at least recognise them. It is about making better decision today.

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PART III RESEARCH AND DEVELOPMENT EVALUATION

Part III of this sourcebook include nine chapters and deal with the various aspects of R&D evaluation. The concepts of monitoring, evaluation and impact assessment are defined and a framework for comprehensive impact assessment of R&D investment is developed in chapter 12. The different types of evaluation in relation to the project cycle are identified and discussed. Chapter 13 an attempt to differentiate evaluation research from research evaluation and the desirable attributes of a good evaluation is outlined. The three classes of evaluation research are also described. An overview of Evaluation activities are presented in chapter 14.

In the subsequent chapters topics such as utilization focused evaluation; participatory evaluation; evaluation as a research management tool, overview of R&D evaluation methods; Management Information System; and design considerations for an M&E system are also discussed. Very often managers and senior officers are asked to participate in evaluation missions. These assessments go beyond the typical impact studies to look at various aspects of a R&D system. An exposure to a wide range of topics dealing with broader issues of evaluation may assist them in undertaking such challenging studies. Therefore, this section was designed to provide a wider exposure to various elements dealing with M&E. These aspects are covered very briefly. The interested reader may consult the key references identified in order to obtain additional information

Introduction

The process of monitoring, evaluation (M&E) and impact assessment is the primary means of collecting and analysing information, and is thus essential for good project management. In order to be used in a more positive manner, management and staff must have a common understanding of the importance of the process involved, and the contribution it can make to achieve the objectives of the technology development and transfer. To be effective, monitoring, evaluation and impact assessment should be participatory, and should be on integral part of project planning and implementation.

In this chapter the concepts of monitoring, evaluation, and impact assessment are defined and a framework for comprehensive impact assessment is developed. The emphasis is on the process, not on individual project M&E.

Monitoring

Monitoring is a continuous assessment of both the functioning of the project activities in the context of implementation schedules and of the use of project inputs by the targeted population in the context of design expectations. The goals of monitoring are:

- To ensure that inputs, work schedules and outputs are proceeding according to plan, i.e., that project implementation is on course;
- To provide record of input use, activities and results; and
- Early warning of deviations from initial goals and expected outcome.

Thus, monitoring is a process which systematically and critically observes events connected to a project in order to control the activities and adapt them to the conditions. Key steps in the monitoring process are:

1. Recording data on key indicators, largely available from existing sources, such as time sheets, budget reports, supply records.
2. Analysis performed at each functional level management. This is important to assume the flow of both resources and technical information through the system.
3. Reporting, often through quarterly and annul progress reports, oral presentations organised by project staff.
4. Storage, whether manual or computerised, should be accessible to managers at different levels of the system.

Monitoring is an internal project management tool. Integrating monitoring into implementation increases the accuracy of the collected information, reduces the cost of acquisition, increases the focus (alertness) of the participating scientists and reduces the time lag for management corrections. Therefore, the emphasis is placed on simple methods. The various objectives of an M&E system are summarised in Box 12.1.

In the context of research, monitoring includes the periodic recording, analysis, reporting, and storage of data about key research and extension indicators. Data includes physical and financial information, details of inputs and services provided to beneficiaries, and data obtained from surveys and other recording mechanisms. Monitoring primarily provides information on project performance and gives signals on whether an activity is proceeding according to the plan. Monitoring is essential for evaluation.

Checking implementation
- Record inputs, activities and outputs;
- Identify deviations from work plans;
- Identify constraints/bottlenecks;

Assessing performance, quality and relevance:
- Overall efficiency (cost effectiveness);
- Overall effectiveness (achieving objectives);
- Suitability of new methods and technologies under testing at the field sites (relevancy);
- Long-term impact (contribution to development objective)

Reflecting and learning
- Learning from achievements and mistakes;
- Increase capacity to perform better in the future; and
- Take corrective action;

Communication
- Share progress and results with others

Box 12.1: Objectives of M&E

It can also provide information on the socio-economic indicators for ex-post evaluation assessment. One could simultaneously monitor the resource use, i.e., of funds and personnel, as well as the process. Monitoring of the process may be accomplished through *inter alia* review meetings and periodic seminars. This permits management to compare the progress of work against planned activities, detect deviations, identify bottlenecks, and take corrective action while research is in progress. Monitoring and Evaluation are closely linked (see Figure 12.1) and are an integral part of project cycle (see Figure 12.2)

Process Monitoring

In the recent past a distinction has been made between process monitoring and progress monitoring. Conventional progress monitoring focuses on physical, financial and logistical aspects of projects whereas process monitoring deals with critical processes which are directly related to the project objectives. An ideal M&E system should contain elements of both progress and process monitoring. The development of process monitoring was part of social science's response to the need for field research data relevant for decision-making within a learning process approach.

An underlying assumption of process monitoring is that there is an ideal way in which a process should develop; that there is an objective towards the process ought to lead. Process monitoring tells the project staff and management that what was being observed is close to ideal. If not, then what needs to be done to steer the process closer to that "ideal"? Process monitoring is a continuous process of observation, interpretation and institutional learning. The core of process monitoring is addressing key project processes and identification of problems and bottle necks resulting from them

Figure 12.1: Relationship of Monitoring and Evaluation

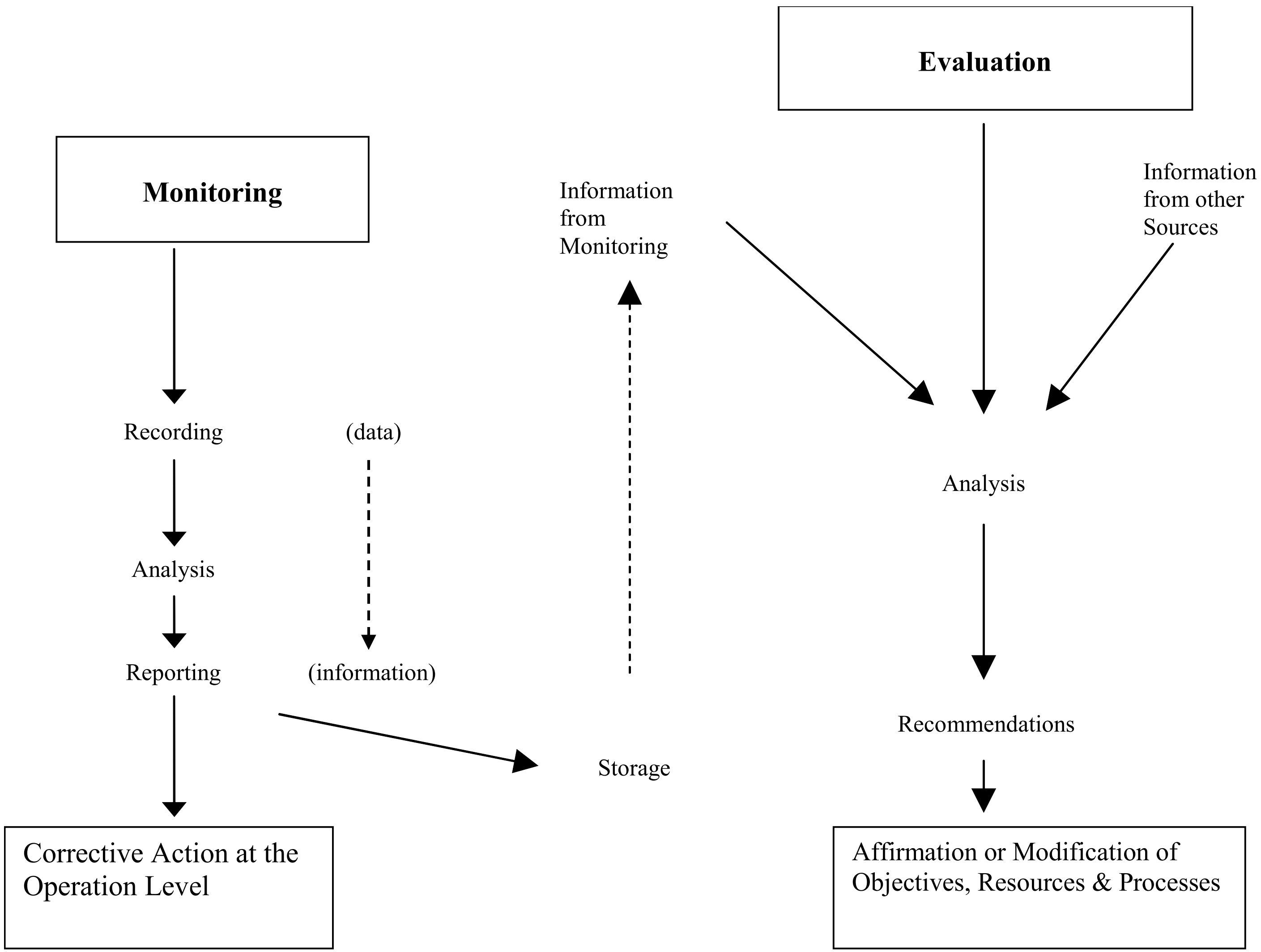
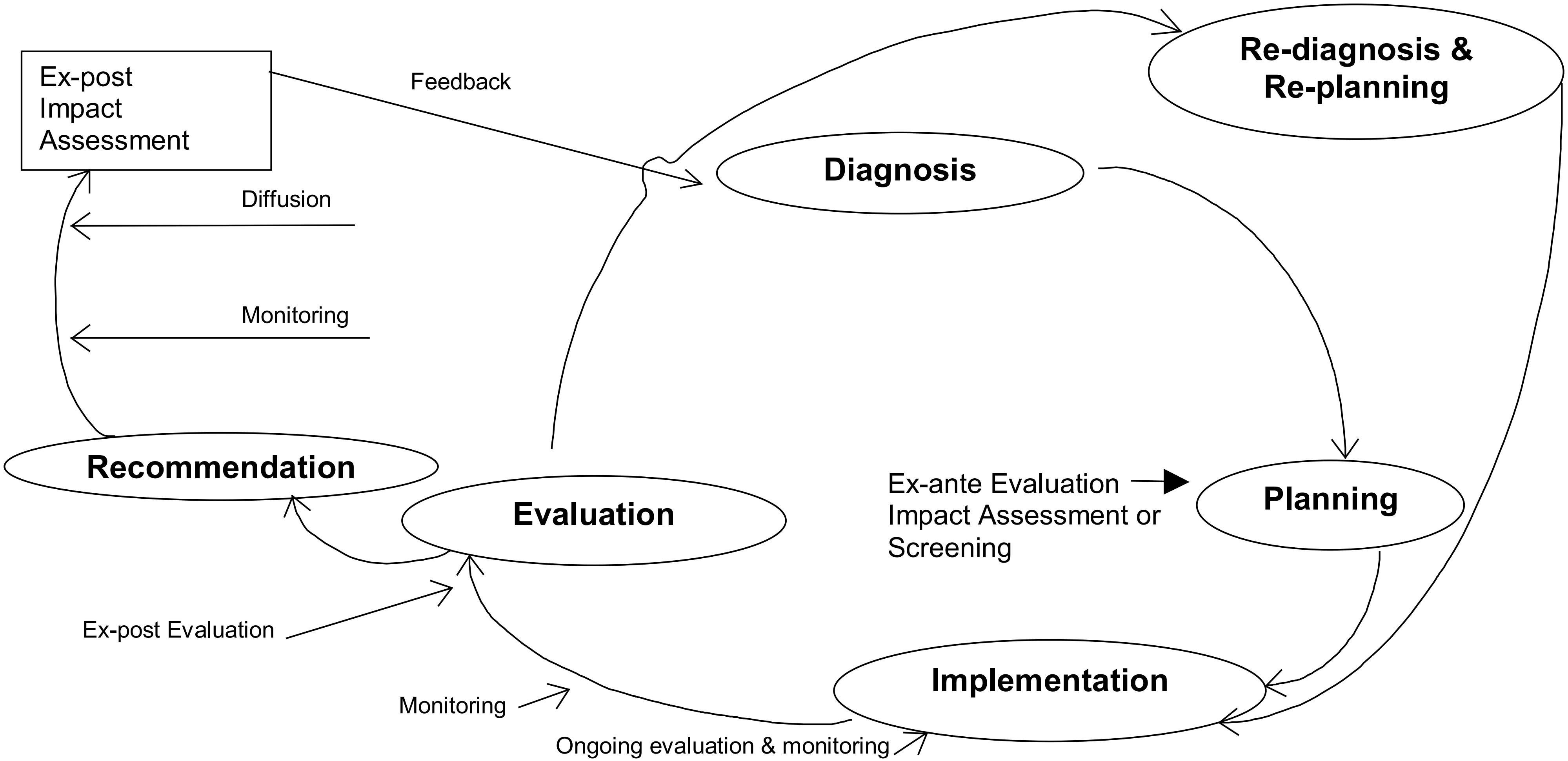


Figure 12.2: M & E and Programme/Project Cycle



Key feature of Process Monitoring

The difference between the conventional progress monitoring and process monitoring are summarized in Table 12.1.

Table 12.1: Process Monitoring and Progress Monitoring

Process Monitoring	Progress Monitoring
• Concerned with key processes for project success	• Primarily concerned wit physical inputs and outputs
• Measures results against project objectives	• Measures results against project targets
• Flexible and adaptive	• Relatively inflexible
• Looks at broader socio-economic context in which the project operates, and which affects project outcome	• Focuses on project activities/outcomes
• Continuous testing of key processes	• Indicators usually identified up front and remain relatively static
• Selection of activities and processes to be monitored is iterative, i.e., evolves during process of investigation	• Monitoring of pre-selected indicators/activities
• Measures both quantitative and qualitative indicators, but main focus is on qualitative indicators	• Measures both qualitative and quantitative indicators, but main focus is on quantitative indicators
• A two-way process where information flows back and forth between field staff and management	• A one-way process where information flows in one direction, from field to management
• People-oriented and interactive	• Paper-oriented (use of standard formats)
• Identifies reasons for problems	• Tends to focus on effects of problems
• Post-action review and follow-up	• No post-action review
• Includes effectiveness of communication between stakeholders at different levels as a key indicator	• Takes communication between stakeholders for granted
• Is self-evaluating and correcting	• Is not usually self-evaluating and correcting

Source: World Bank, 1999

The salient features of process monitoring are

- Process monitoring observe features of process in each project phase and provides feedback for management for making necessary changes
- Process monitoring investigates processes within the community, project and wider socio-economic context.
- Process monitoring help projects to learn from their own experiences and adapt to improve their effectiveness over time
- Process monitoring looks at both internal and external processes
- Process monitoring evaluates the quality and effects of project interventions and outcomes
  - Involves participant observation and critical assessment
  - Helps understand the motives, intentions and actions of different actors in a project
- Process monitoring can be used at different levels (individuals, within project, interaction between projects and other actors, wider institutional and socio-economic context) and to analyse the interaction between these levels.
- Process monitoring is also used to assess the impact of changes in project strategies, rules and procedures

The key steps in the process are discussed in the next section

Key steps in Process Monitoring

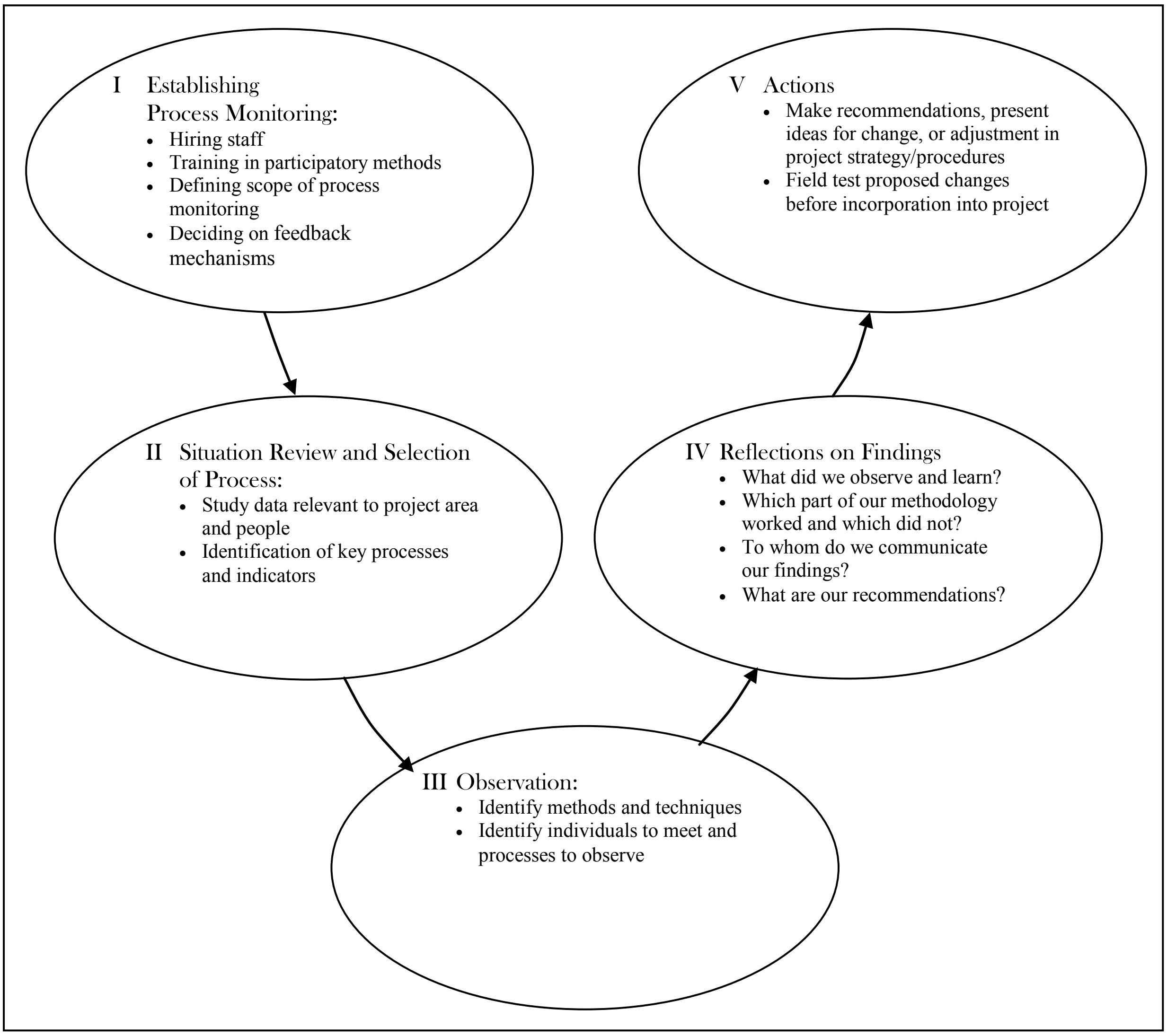
The proponents of this approach identify five steps in implementing process monitoring as shown in Figure 12.3.

These steps are:

- Establishing the process monitoring unit/team
- Situation review and selecting key project process and indicators
- Observing key processes
- Reflecting on/analyzing findings
- Follow up action.

These steps are discussed in the following sections.

Figure 12.3: Steps involved in Process monitoring



Source: World Bank 1999

Step 1: Establishing Process Monitoring Unit/Team

This involves a number of steps such as recruitment of staff, defining the scope including documentation and information sharing.

Recruitment of staff

The first step in the establishment of the unit/team is recruiting/identifying the staff. In forming the unit/team, make sure:

- That the individuals involved are experienced in community development and M&E
- Trained in participatory methods, participant observation conflict resolution etc.
- To be effective gender balance is crucial

The unit/team should be located within the project, but ideally have its own budget for transport, office equipment and communication. It is also important to develop working relationship with staff from other units

Defining the scope of Process Monitoring

It is important to define the scope of process monitoring from the very beginning. In defining the scope it is important to note that the process monitoring cannot be carried out independently of progress monitoring. Process monitoring should be an integral part of the projects own M&E system. The process monitoring activities should focus on project rules and procedures and communications between key actors and levels. The scope should define the objectives, boundaries, information recording as well as sharing of such information. In defining the scope

- It is useful for process monitoring to be both "internal" to project, but with "external" linkages and independent reporting channels
- Must establish channels and procedures for information flow to and from the unit
- Information should be recorded and shared with key stakeholders
- Findings should be presented in an easily readable and usable form

The ultimate test of the success of process monitoring is whether the information it generates leads to concrete decisions and actions to address critical issues to improve project performance

Step 2: Situation review and selection process

This step enables the unit/group to reach a common understanding of which processes are important and why? Primarily the step involves collecting data on projects, project area, beneficiaries, discussing issues with key resource people and stakeholders.

There are basically two approaches for selecting key processes for monitoring

- Key processes should be closely linked to project objectives and the project cycle. Key indicators are then identified for each stage in the project cycle. The number of processes selected for monitoring should be limited.
- Process not previously identified for monitoring, but in which the project experiences problems and/or bottlenecks may be added to the key processes identified earlier

The selection of processes to be monitored should be made in consultation with project management, staff, as well as beneficiaries and other relevant stakeholders.

Step 3: Observing key processes

It is important to observe processes as objectively as possible. At times specialized training may be required to minimize biases in people's ability to observe objectively. Collection and analysis of qualitative information also requires relevant skills and experience. Therefore, it is important that process monitoring staff receive appropriate training before they begin their work.

In addition a number of other questions also need to be answered in order to implement an effective process monitoring.

- Who makes the observation?
- What methods will be used for process monitoring?

The best methodology should be identified and agreed upon in the advance. If the issue deals with community processes then methods such s transect walks, participatory need assessment, participatory discussions, and participatory resource mapping are suitable. Some of the common tools used in process monitoring are summarized in Box 12.2.

Box 12.2: Useful Tools for Process Monitoring

- Participant Observation
- Participatory Discussion (Focus Group)
- Semi-structured Interview
- Transect Walks
- Participatory Resource Mapping
- Participatory Need Assessment
- Process Monitoring Working Groups
- Project Planning Meetings
- Special Studies
- Topical Sessions

Step 4: Reflections on Analysing findings

When the observation is completed, it is necessary to assess the information collected. The team has to address a number of issues when analyzing observations. These include:

- What turned out differently than expected?
- Which part of the strategy to gain insight into the process produced desired results and which didn't?
- Was a cross section of views sought and accommodated?
- With whom do the findings need to be shared?
- In what form should these be presented?

It is crucial to document answers to these questions and communicate to the relevant stakeholders.

Step 5: Follow up action

Based on the observations and analysis the unit/group should make recommendations for project management/institution. It is also imperative to identify and discuss the implications of the proposed changes.

Developing Process Monitoring Indicators

One of the crucial steps in the M&E process is the identification of relevant and critical indicators. Indicators are variables that describe or measure changes in an activity or situation over time. They are useful tools for monitoring the effects of a process intervention.

Developing a set of indicators follow a three steps approach:

- Defining project objectives
- Asking relevant questions (What? Whom? When?)
- Identifying indicators.

a) Defining project objectives and activities

It is practically impossible to identify indicators and use them in the monitoring and evaluation process if the objectives, activities and output of the project are not clearly defined and understood by all stakeholders. Developing an "objective tree" (based on the problem analysis/problem tree) and distinguishing priority immediate, intermediate and long-term objectives is a good way to start the process. A useful tool for defining objectives is the Logical Framework Analysis.

b) Asking questions

Once the objectives are sorted out and agreed upon a number of questions need to be answered before identifying indicators.

- What do we want to know? (and how does it relate to the project objectives)
- What information do we need and for what purpose?
- What is the minimum number of indicators that will tell us that we have accomplished the objectives
- How, when and by whom these information be collected?

- What are the cost (resource) implications

Answers to these questions will help us to identify the indicators and establish an M&E system for the project/institution

c) Identifying indicators

Identification of the final set of indicators should be done in a participatory manner. While identifying indicators it is worth noting that

- Each objective or activity can be measured by different indicators
- Indicators may change over time as projects internal and external environment change and as the project activities change
- Developing useful indicators is a process sometimes involving negotiation between conflicting interests

A final test for the indicators selected is to make sure that they are SMART (specific, measurable, attainable, relevant and timely)

Note:

- Ideally process monitoring methods and indicators should be effectively integrated into the projects M&E system
- There should be clear criteria for monitoring processes, with clearly defined roles, responsibilities, methodology, realistic time frame and resources for implementation
- An essential prerequisite for effective process monitoring is open mindedness and willingness to listen to the views of others. Process monitoring must be flexible and adaptive in response to changes
- Process monitoring should operate at all levels. Focusing only on one level can be misleading by obscuring the impact of other forces on project effectiveness.

Evaluation

Evaluation is a much broader concept and is used to assess the following:

- The potential impact of research in priority setting and planning exercises;
- The performance and quality of activities in progress;
- The successful completion and relevance of activities; and
- The ultimate impact of results on the achievements of development objectives.

Any assessment, appraisal, analysis or reviews are in a broad sense evaluative. Evaluations result in a set of recommendations, which may address issues of planning, such as a shift in program objectives or contents or program implementation. Information from an evaluation is used in the management of technical programs, personnel, and financial resources.

Evaluation in general addresses four important aspects of the program, namely: performance, quality, relevance and eventual impact.

- Performance compares achievements with expected output. It is primarily concerned with the use of resources and the timelines of the activity and is determined mostly through monitoring and on-going evaluation. However, assessing the success or failure of research goes far beyond determining whether resources were used according to plan or activities were carried out on time.
- Quality deals with the adherence to accepted standards of scientific work and precision. The quality of research is determined almost exclusively through some form of peer/expert review.
- Relevance of research at each level of the research investigates on research relevance to objectives, which ultimately reflect on the developmental objectives. Relevance is closely related to the problem being addressed and the target group under consideration. Relevance is primarily assessed through peer or expert review and beneficiary assessment.
- Impact deals with the effect of the research output on the ultimate users often referred to as *"People level impact."*

Types of Evaluation

Evaluations are most often categorised according to when they occur in the project cycle and their purpose.

- Occurs before (ex-ante) the event - to assess the potential impact of research.
- Occurs during (on-going) the event - to evaluate the performance and quality of the research project in progress.
- Immediately after the event (ex-post) - to determine the successful completion and relevance of research project.
- Several years after research results have been achieved (impact) - to assess its ultimate impact on development.

Ex-ante evaluation

Ex-ante evaluation is a research planning process which includes a comprehensive analysis of the potential impact of alternative activities before implementation. As the name implies the evaluation is done prior to the initiation of the project, at this stage not too much is known about the proposed project and estimates of costs and benefits are sketchy and the values assigned to them are only 'ball-park" figures based on informal judgement.

Methods used are peer or expert reviews using checklists, scoring models, and even cost-benefit analysis. To make *ex-ante* evaluation more effective, there should be participation from different disciplines and more comprehensive criteria must be applied. Through *ex-ante* evaluation, one could define the baseline against which progress will be measured, set targets, and state the assumptions used in making the projections. The indicators to be monitored should also be specified in order to assist *ex-post* evaluation.

On-going evaluation

On-going evaluations that are conducted throughout the technology development and transfer process are more useful for research management than *ex-ante* and *ex-post* assessments. Here on-going activities are reviewed at critical stages to determine if they should be continued, modified or aborted. They are used to analyse the use of resources, the quality of research, and the continuing relevance of research programs and projects. On-going evaluation is often conducted through peer reviews. On-going evaluation addresses problems associated with the day-to-day management of interventions and also can indicate the need for changes in project objectives and targets.

Monitoring is fundamental for on-going evaluation. It primarily tracks down the provision and delivery of inputs and services, the generation of information on the ability and deployment of staff, infrastructure, equipment, supplies, services, and funds for projects within a program. In on-farm research, the on-going evaluation is used to obtain feedback from the target group; and is largely accomplished through a series of meetings at the site with peers, farmers, extension staff and NGOs.

Ex-post evaluation (immediately after the completion)

An *ex-post* evaluation, or final evaluation, assesses the project's performance, quality, and relevance immediately after the project completion. It attempts to measure the effectiveness and efficiency of a completed activity and includes an analysis of the original assumptions used in planning. A good *ex-post* evaluation is linked to *ex-ante* evaluation, and can best be conducted where a baseline has been originally defined, targets have been projected, and data has been collected on important indicators.

Ex-post evaluation is analysed for the project from beginning to end, determining whether project objectives were attained, causes for discrepancies, costs, and the quality and relevance of the research. *Ex-post* evaluation often considers such aspects as the cost effectiveness of research, its potential relevance to national development goals, the response of the research to an urgent and important problem, the acceptance of the results by farmers (end-users) and development agencies, and the contribution of the research to scientific progress.

Common criteria for evaluating scientific research are most notably number and quality journal publications and instances of citation (citation index). These are not comprehensive enough to consider the appropriateness of the technology or its value to development. Therefore, the classical criteria need to be broadened to include user (i.e., farmers') satisfaction.

The methods typically used for ex-post evaluation are statistical evaluation, economic evaluation, agronomic assessment, and farmers/community assessment. Advanced preparation for *ex-post* evaluation should include precise plans on documentation needed, people to interview and sites to visit. Some supplementary information may need to be gathered through surveys or interviews. Most evaluations use a blend of interviews, field visits, observations, and report writing. *Ex-post* evaluation also tries to clarify the internal and external factors affecting the outcome of the project.

Ex-post evaluation can provide important insights into the research process and provide a basis for comparing alternative organisational methodological approaches. The lessons learned could be systematically incorporated into subsequent evaluations making the processes much more relevant and efficient.

Impact evaluation

This is a form of *ex-post* evaluation. Impact evaluation attempts to determine the extent to which TDT programs have contributed to larger development goals, such as increased farm production, or improved food security, poverty alleviation, etc. Typically, it is conducted several years after the results have been released making it less useful as a management tool than the other types of evaluation. *Ex-post* impact assessments are often used to convince policy makers to allocate more resources to research.

If the project and program evaluations are to be used to support impact evaluations, this should be considered during *ex-ante* evaluations and the necessary baseline data and an M&E system should be set up in advance to serve this purpose.

Impact evaluation must distinguish between the contribution research make to national development from the contributions made by other factors such as existence of good extension services, agricultural inputs, adequate infrastructure, and favourable marketing and pricing policies. It has been shown that benefits are relatively easy to attribute in the case of single commodity technologies, such as high yielding varieties of rice under irrigation in Asia. It has proved more difficult to do this in more diverse and complex systems as seen in most of sub-Saharan Africa. The key concepts in *ex-post* impact assessments are causality, attribution and incrementality. These aspects are discussed in subsequent chapters.

Ex-post impact assessments usually require extensive and often expensive data collection and a thorough analysis of socio-economic factors. The results of impact evaluations have broad implications for future priority setting, not only for research, but also for development support services. The types of impacts and methods used are discussed in the following sections.

Meaning of Impact

The term “impact” means different things to different people. In discussing the impact of any research program, one can identify two broad categories of interpretations (Anderson and Herdt, 1990). In the first category, some people look at the direct output of the activity and call this an impact, e.g., a variety, a breed, or a set of recommendations resulting from a research activity. Most of the biological scientists belong to this category. The second category goes beyond the direct product and tries to study the effects of this product on the ultimate users, i.e., the so-called people level impact. The people level impact looks at how fit the program is within the overall R&D to discover facts (research) that have practical beneficial application (development) to the society. Impact begins to occur only when there is a behavioural change among the potential users. This second type of impact deals with the actual adoption of the research output and subsequent effects on production, income, environment and/or whatever the development objectives may be.

The people level impact of any research activity cannot be assessed without information about the (extent) number of users and the degree (intensity) of adoption of improved techniques, and the incremental effects of these techniques on the production costs and output. The adoption of any technology is determined by several factors, which are not part of the original research activity.

In any comprehensive impact assessment, there is therefore a need to differentiate between the research results and the contributions of research to development, i.e., the people level impact, and both aspects should be addressed. Impact assessment is directed at establishing, with certainty, whether or not an intervention is producing its intended effect. A program that has positive impact is one that achieves some positive movement or change in relation to objectives. This implies a set of operationally defined goals and a criterion of success. There is also a need to establish that the outcome is the cause of some specified effort. As such, it is important to demonstrate that the changes observed are a function of the specific interventions and cannot be accounted for in any other way. As pointed out earlier, the three basic principles to be observed in any impact study are causality, attribution, and incrementality.

Purpose of Impact Assessment

The purpose of impact assessments of agricultural technology development and transfer (TDT) activities depends on when the assessment is done. Impact assessments can be undertaken before initiating the research (*ex-ante*) or after the completion of the research activity (*ex-post*) including the technology transfer.

The purpose of undertaking an impact assessment prior to starting a research project/ program is to assist the research manager/ research team in planning and priority setting activities. This will enable one to:

- Study the likely economic impact of the proposed research activity/ project;
- Formulate research priorities by examining the relative benefits of different research programs;
- Identify the optimal combination of research program; and
- In addition, an *ex-ante* assessment can also provide a framework for gathering information to carry out an effective *ex-post* evaluation.

Given the resource constraints confronting the research managers and researchers, *ex-ante* impact assessment is becoming a powerful planning tool in research management.

The various purposes for conducting an impact assessment after the completion of the program (*ex-post*) include:

- To study the impact and to provide feedback for researchers, research managers, planners and policy makers;
- Lessons learned can be used to improve the management and decision making process with respect to priority setting, implementation, and management of research activities as well as technology transfer;
- For accountability purposes;
- To establish the credibility of the public sector research; and
- To justify increased allocations of research resources.

Impact Chain

The typical impact chain starts from the set of inputs and activities of a project/program to the most highly aggregated development results, such as poverty reduction, food security, environmental protection, etc. The chain also specifies all the main intermediate steps: the activities of a project, the output, the use that others make of this output, the direct as well as possible indirect effects, and the implications of the use of these outputs on the ultimate beneficiaries — society (see Figure 12.4). The output, outcome, and impact are generally sequentially produced over a period of time become more difficult to articulate, measure, and attribute as one moves from outputs to impact.

Collaborative activities

These are the joint actions undertaken by the collaborators, for example a training workshop. Here you are expected to identify all collaborative activities undertaken by ISNAR in the country. List activities, key collaborators, as well as the contributions of each group. Clearly state the objectives of the collaborative activities.

Outputs

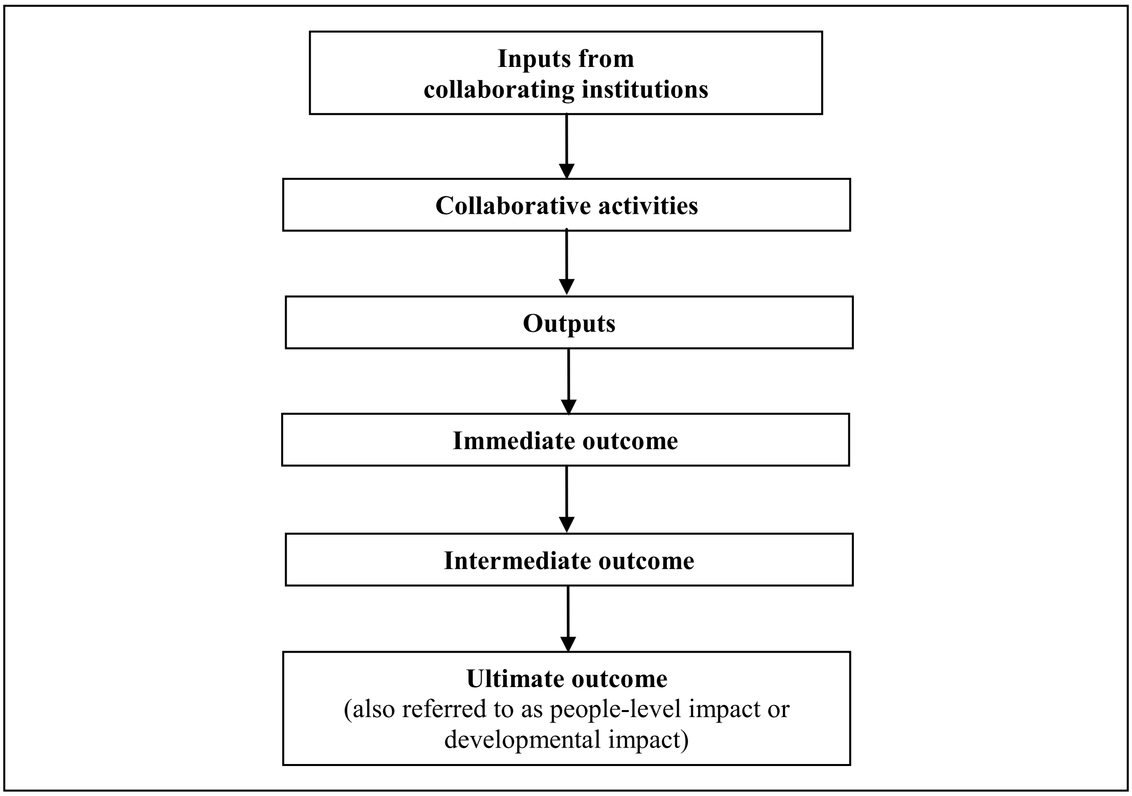
This refers to the results of the program activities, i.e., goods and services produced by the set of collaborative activities. In the case of training activities the outcomes may be trained individuals with acquired skills (are able to apply the skills taught), a set of training materials, and /or trained trainers. See Box 12.3 for examples of the types of research outputs.

Immediate outcome

This refers to the first level effect of the outputs: the observed or documented behavioural changes in those directly affected by program. In the case of training program, how did the training affect the behaviour of the trainee? Did (s)he make any changes in the way of doing business as a result of the training? Did (s)he apply the skills acquired.

In the case of research the first immediate outcome may be a change in the recommendations provided by the extension staff or even the behavioural change to use the direct product ie. adoption.

Figure 12.4: Impact chain



Box 12.3: Types of Research Outputs

The major outputs of R&D activities may be an improved technology or improved set of information. Both types of output will eventually lead to improving the efficiency of agricultural resources.

Improved Technology

On Farm

An improved technology on-farm can be comprised of:

- New enterprise, e.g. a new legume crop species;
- Increased production, e.g., a new crop variety;
- Decreased production costs, e.g., a more efficient technology for the application of chemicals;
- Increased quality, e.g., reduced contamination, increased oil content; and
- Reduced risk, e.g., a more stable yielding crop variety.

Off –Farm

An improved technology off-farm can be comprised of:

- Decreased handling/transport/storage/processing cost;
- Decreased wastage/spoilage; and
- Improved health.

Information

Information can be about the existing technology or the new technology. Both types of information are aimed at improving the returns to research investment. Some examples of improved benefits from information systems are:

- Information on an existing technology which enhances adoption both on-farm and off-farm, i.e., a more rapid adoption and/or a higher level of adoption of existing technology;
- Better management decisions (strategic and tactical) leading to higher profit:
- Better application rates, timing and inputs;
- Improved fertiliser management on sandy soils;
- Quality of research; and institutional changes;
- Reduced risk; and facilitation of other research.

It is worth noting that there is no clear-cut dichotomy between technology and information. For example a new technology must accompany information at least on how to apply it.

Intermediate outcome

This refers to the benefits and changes resulting from the application of the output. In the case of training, what are the effects in the performance of the individual and/or institution as a result of the applications of the skills acquired? In the case of a technology the intermediate outcome may be the effects at the farm/household level ie., increased yield, reduction in cost.

Note: In order to bring about an outcome, the program has to change people's behaviour. By trying to identify and then document the changes in attitudes, knowledge, perceptions, and decisions taken by program target groups, which logically link to the outcomes being observed, we can often acquire a good understanding of the actual impact that the program has. Often, immediate and intermediate outcomes can be measured and documented directly. This requires clearly identifying the various clients of the program and the way in which their behaviour is expected to change. If an expected outcome has been observed after the program activity has started up, then this suggests that the program is having an effect. If we can observe these short-term changes, then the logical case for the program's attributions can be enhanced.

Outcomes are measures of the use that is made of the output by clients and partners. They reflect the value they place on them as intermediate product, which in turn are input in their management decision-making.

Ultimate outcome (impact)

Impact refers to measurable effects of the outputs and outcomes on the well-being of the ultimate beneficiaries of the R&D efforts, namely the poor, the food and nutrition insecure, and the environment. Most socio-economic impacts and developmental impacts fall under this category. Very often the ultimate outcomes are closely linked to the sectoral/regional/national developmental goals.

Since there is considerable time-lag between the realisation of outcome and impact, often one could use proxies or partial indicators in terms of assessing the people-level impact. In addition to program output, a number of other factors may contribute to the realisation of people level impact. Thus attribution may be more difficult.

Note:

- In assessing the outcome and impact, one should focus the analysis on all three levels:
  - individuals (those who are directly involved in the program);
  - institutional level;
  - people level, i.e. the ultimate beneficiaries.
- One may complement his/her observation with expert opinion (from people outside the program who are seen as knowledgeable about the program area, the program's impacts, and the environment in which the program operate).
- If there is documented evidence available (secondary sources such as evaluation reports) about the program output, outcome, and impact, then should be collected, analysed and documented. It is important to show evidence for any claims with respect to outcome and impact, as well as indicate where such evidences can be found

The three basic issues that need to be taken care of in any empirical impact study are causality, attribution, and incrementality. It is important to ensure that the impacts measured are as a result of the intervention/collaborative activities. Incrementality refers to any autonomous endogenous changes that would have taken place in the absence of the collaborative activities or intervention. Attribution problem arise when one believes or is trying to claim that a program has resulted in certain outcomes and there are alternative plausible explanations. Under these circumstances;

- Identify the most likely alternative explanations;
- Present whatever evidence or argument you have to discuss, and where appropriate, discount these alternative explanations; and
- Present whatever evidence there is, that the program is more likely the explanation for the observed outcome.

Addressing attribution problem this way demonstrates that:

- you are aware of the complexity of the situation;
- you acknowledge and understand the other factors at play;

- you are nevertheless concluding (assuming you are) that the most likely explanation for the observed outcome is that the program made a significant contribution.

To sum up, there are four products of concern of collaborative R&D activities: outputs, outcomes, changes in institutional performance, and the final welfare impacts. They are sequentially produced and more difficult to document, articulate, measure, and attribute as one moves from outputs to impacts. Attribution remains one of the methodological challenges in impact assessment studies. This is critical especially for ISNAR, where partnerships and collaborations are an increasing feature of its collaborative activities. Therefore, as far as possible joint impact of various players should be measured rather than trying to separate out the contribution of individual institutions, which may not be feasible in most cases. However it is important to make sure that the inputs and contribution of all partners are appropriately acknowledged.

Three basic types of impact evaluation are possible: qualitative, quantitative, and a mixture of both. Qualitative evaluations describe the process by which the outputs of research and development activities have influenced institutional innovations and the eventual social impacts. It seems that the most appropriate approaches to impact assessment should involve a mixture of both qualitative and quantitative methods. Retrospective narratives are essential components of the farmer and indeed provide the basis for quantitative estimates and the related issue of attribution.

Types of Impact

Impact studies can be carried out to study the impact of a particular innovation/ technology, on a research program, or on a research program plus complementary services (such as extension, marketing, etc.). Impacts can also be measured at the individual household level, target population level, as well as national and regional levels (primary sector, or secondary sector, or overall economy). The direct product of an agricultural research project/ program may be an improved technology (embodied or disembodied), specialised information, or research results (reports, papers and publications). See Box 12.3 for a discussion of the direct product of research. There is general consensus that an agricultural TDT effort in addition to producing the direct product of research could potentially lead to five different types of impacts (see Box 12.4), namely production impact, economic impact, socio-economic impact, environmental impacts, and institutional impact. Institutional impact refers to the effects of TDT efforts on the capacity of the research and extension program to generate and disseminate new production technologies. These different impacts and the appropriate methods to measure them are discussed in the following section.

Box 12.4: Types of Impact

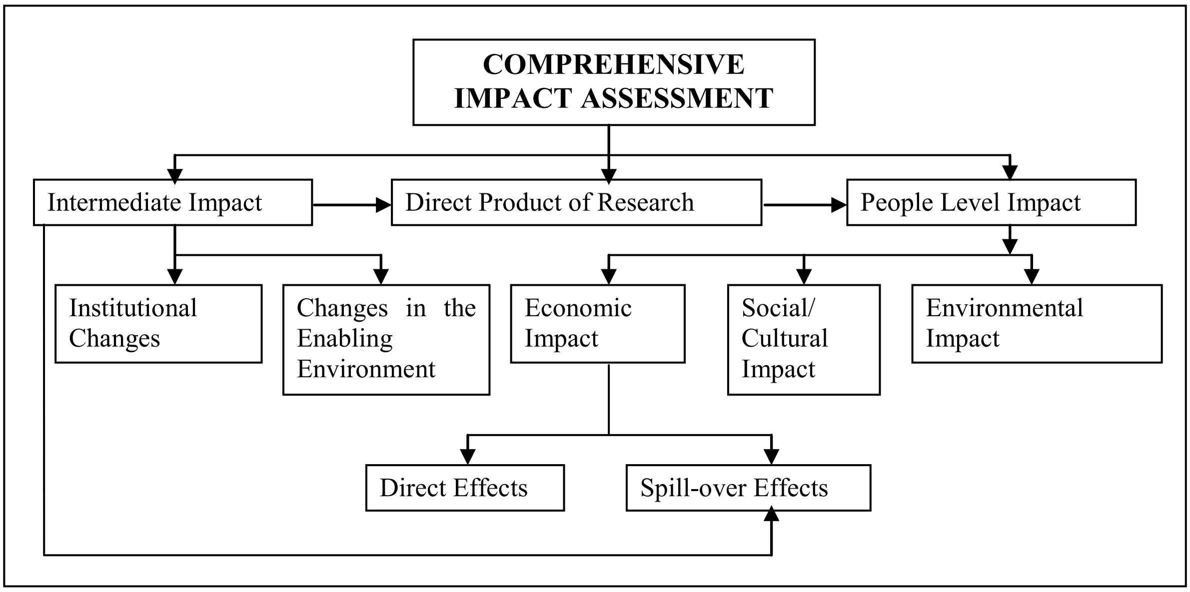
- Production Impact
  - Yield/Productivity gains
  - Acreage
- Economic Impact - Comparison of Benefits and Costs
  - Income
  - Rate of Returns
  - Reduced Risk
  - Number and Type of Jobs Created or/Reduction in Employment rates per type
  - Distribution of Benefits
    - → Gender
    - → Income Group
    - → Location
  - Changes in resource allocation e.g. labour patterns
  - Nutritional Implications
- Social / Cultural Impact (can be positive or negative)
  - Changes in Status of Women
  - Changes in the Knowledge and Skill Level of People
  - Changes in the Health of Various Groups of People
- Environmental Impact (can be positive or negative)
  - Air and Water Pollution
  - Soil Erosion and Sedimentation
  - Contamination of soil and Water by Herbicide or Pesticide Residues
  - Effects on the Long-Term Functioning of Biosphere, Potential Climate Change, etc.

- Effects on Biodiversity
- Institutional Impact
  - Changes in Intermediate Organisational Structures of Methods and Plans
  - Changes in the Number and Composition of Scientists
  - Changes in the Proportion of Funds Allocated to Research
  - Changes in the Mix of Public and Private Sector Participation
  - Improvement in Interdisciplinary Involvement

Based on the previous discussions, there are three broad categories of impact that form part of a comprehensive impact assessment exercise. The first is the direct outcome of the research activities. The second, the intermediate impact is concerned with the organisational strategies and methods used by researchers, and other actors in conducting more effective technology development and transfer. The third is the effects of the direct product(s) on the ultimate beneficiaries. This is the so called people level impact. The people level impact can be economic, socio-economic, socio-cultural, and/or environmental. The various types of impact are summarised in Figure 12.5.

Figure 12.5: Framework for Comprehensive Impact Assessment

Source: Anandajayasekaram *et al.* 1996



Overview of Impact Assessment Methods

A comprehensive impact assessment should simultaneously assess the various impact of the TDT. The various techniques and methods used to assess the different types of impact are summarised in Table 12.2 and discussed in the subsequent sections.

Table 12.2: Impact types, Techniques, and Methods used in a Comprehensive Assessment

IMPACT TYPE	METHOD	TECHNIQUE
INTERMEDIATE IMPACT • Institutional Changes • Changes in the Enabling Environment	Survey , Monitoring	Simple Comparison/ Trend Analysis
DIRECT PRODUCT OF RESEARCH	Effectiveness Analysis using Logical Framework	Simple Comparison – Target vs. Actual
ECONOMIC IMPACT Micro, Macro, Spill-overs	Econometric Approach Surplus Approach	Production Function Total Factor Productivity Index number methods and derivatives
SOCIO-CULTURAL IMPACT	Socio-economic Survey/ Adoption Survey	Comparison over time
ENVIRONMENTAL IMPACT	Environmental Impact Assessment	Various • Qualitative • Quantitative

Direct product of research - effectiveness analysis

The most commonly used approach for assessing the direct product of research is known as effectiveness analysis. A useful starting point for effectiveness analysis is the logical framework of the project. The logical framework permits the assessment of the degree to which the research activities have made changes in the desired direction. The logical framework itself is a simple matrix that provides a structure for one to specify the components of a program/ activity and the logical linkages between the set of means (inputs and activities) and the set of ends (outputs). This logical framework makes the impact assessment process transparent by explicitly stating the underlying assumptions of the analysis.

The effectiveness analysis is a simple comparison of these targets to actual or observed performance of the project. Three sets of comparisons are identified in the literature: "before" and "after" comparison (also called historical comparison); "with" and "without" comparison; and "target" vs. "achievement" comparison. The most useful comparison is target vs. achieved. The targets need not be completely achieved for the project to be deemed effective. The movement in the direction of the desired target is evidence of project effectiveness.

Evaluating the impact of intermediate product(s)

The link between the intermediate product and the ultimate economic benefit is not clear and, therefore, tends to be ignored in most impact assessment studies. The evaluation of the intermediate product is made difficult by the fact that the benefits of these products are not easy to quantify. Thus, most studies acknowledge the fact that having the institutional capacity to conduct agricultural TDT is of paramount importance. These studies, however, do not include the benefits in the assessment of the impact. The costs that are easy to quantify are usually included. Thus, the assessment of the intermediate product has been a tricky issue. The practice has been to trace the changes in institutional capacity over time using either simple trend analysis or comparisons over time. This requires baseline information on these indicators and careful monitoring. The results from these analyses can be incorporated into the quantitative analysis through a multi-criteria analysis.

People level impact

As pointed out earlier, the people level impact can be economic, socio-cultural, and environmental.

The Economic Impact

The economic impact of TDT initiatives can be traced through its effect on production and income. The approach used is called the efficiency analysis. Efficiency analysis assesses the people level impact by comparing the benefits that society gets from TDT and the costs incurred in conducting TDT programs. The benefits and costs are normally collapsed into a single number, the rate of return (ROR). There are two broad ways of calculating the rate of return to TDT: ex-ante and ex-post. The ex-ante methods are useful as research planning tools as they aid in the selection of the research portfolio, priority setting, and resource allocation. The ex-post studies are useful for justifying past TDT investments, and demonstrating the payoff of such investments.

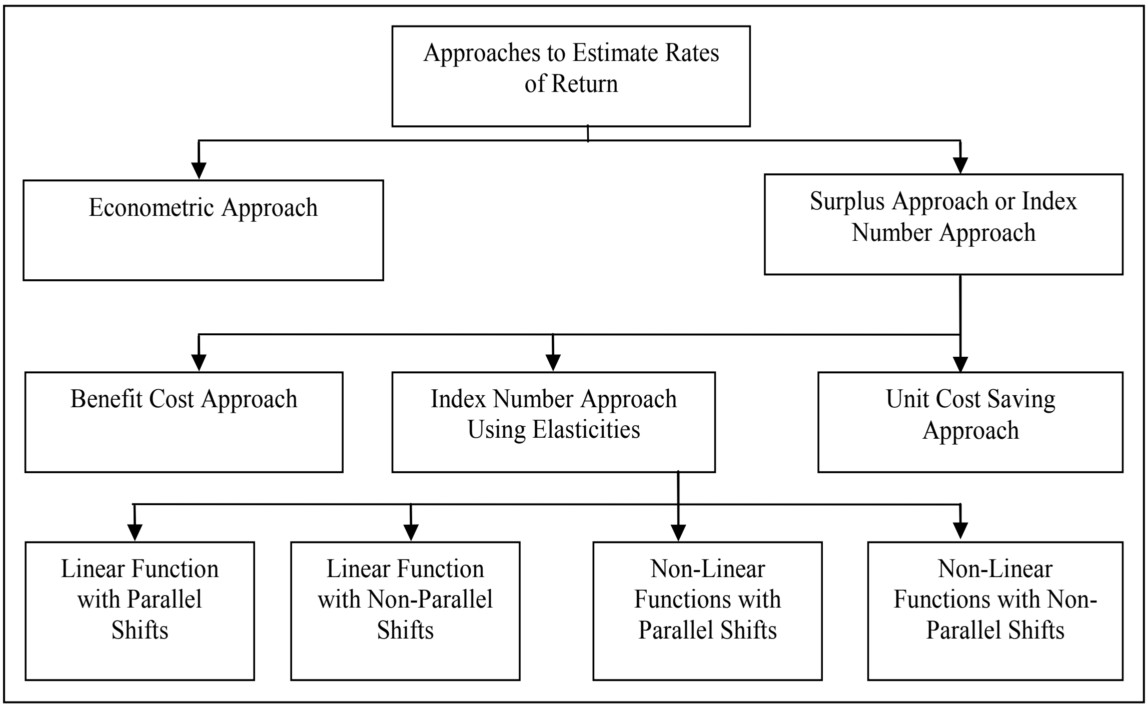
The ex-ante methods for estimating RoR include benefit- cost analysis, simulation models, and mathematical programming models. The last two methods are data and skill intensive and, therefore, rarely used.

Ex-post methods for RoR estimation can be divided into two broad groups, as shown in Figure 12.6. The econometric method uses the production function in which research and transfer activities are considered inputs and give the marginal rate of return (MRR) to agricultural TDT. The MRR quantifies the returns to the last dollar expended in the research project. To determine the optimal allocation of funds, it is necessary to know the marginal benefit of the last research dollar invested. This is the only method that allows for the separation of the effects of research from those of extension and other support services. However, the data requirements have reduced the extensive use of this method.

The second group of methods are the *surplus approaches*. These methods calculate the benefits of TDT as the net change in producer and consumer surplus, employing a partial equilibrium analysis. The different techniques are based on the difference in the assumed nature and elasticities of the supply and demand functions. The benefit-cost approach has various combinations of the nature of the supply shift and the functional form of the supply and demand curves. The cost-saving approach is in between these two approaches, but based on the same theoretical foundation.

These methods calculate the average rate of return (ARR). The average or internal rate of return takes the research expenditure as given and calculate the RoR for the project or program in its entirety. This provides information to assess the success of the project in terms of generating adequate returns. However, the ARR measure is not always helpful in determining if the allocation of research funding to the project was appropriate. Because of the historic nature of ex-post evaluation, the results of these studies have mainly been used as political instruments to secure future funding. They demonstrate how efficient past investments were, but not necessarily where research resources should be allocated in the present, or the future. For a detailed description of the various techniques see Anandajayasekeram et al. 1997. For our purposes a simple technique such as a partial budget and cost benefit framework can be effectively used to estimate RoR of TDT efforts. The different techniques used to estimate the RoR are discussed individually in the subsequent chapters.

Figure 12.6: Approaches for Estimating Rates of Return



Source: Anandajayasekaram 1996

Socio-Cultural Impact

Socio-cultural impacts include the effects of research on the attitude, beliefs, resource distribution, status of women, income distribution, nutritional implications, etc of the community. These can be assessed through socio-economic surveys and careful monitoring. To be cost effective, appropriate socio- cultural questions can be included in adoption survey questionnaires.

Environmental Impact

The adoption of modern agricultural technologies has often resulted in external benefits and costs largely through its effects on the environment. For example, the use of fertilisers or pesticides may lead to surface and ground water contamination by toxic chemical and algae, resulting in significant environmental costs. On the other hand, adoption of minimum tillage technology and herbicides by farmers has probably had environmental benefits in the form of reduced soil erosion and nutrient loss.

The full assessment of environmental quality issues requires complex analysis of physical, biological, social, and economic processes. This also leads into some measurement problems. Such a breadth of analysis is likely to be beyond the scope of most agricultural research assessment activities. Nevertheless, some assessment of environmental impact is necessary when evaluating agricultural research, especially where the environmental impact of the application of the research is likely to be significant. In the absence of data required for a thorough analysis, it may still be possible to identify qualitatively the nature of the social benefits and costs, together with the likely gainers and losers.

Multiple Impacts of Technologies

Technologies often have impacts in more than one area. For example:

- Improvement in one or more categories can be partially offset by a decline in another category:
  - Higher quality may be achieved at the cost of lower yields or higher costs;
  - Increased yield or quality may be at the cost of higher risk; and
  - Decreased risk could be accomplished with a reduction in yields.
- Research often has benefits in more than one category:
  - Breeding of new grain legumes has resulted in higher yields for subsequent crops lower "N" requirements of wheat crops, and higher protein levels in wheat; and
  - Field trials of a new crop may serve to promote adoption and to fine-tune agronomic management practices.
- The impact of research is often not confined to the enterprise which was the subject of the research:
  - Increased profitability of A:
    - → Draws resources from alternative enterprises, and;
    - → Imposes an opportunity cost that needs to be recognised;
  - There could also be positive spin-offs, e.g. grain legumes and fixation of nitrogen.

All aspects need to be considered in assessing the impact of any technology.

Multi-Criteria Analysis

As discussed in the previous sections, due to the wide-ranging implications of agricultural research to the society, no single method is sufficient to adequately capture these impacts. Therefore, a multi-criteria analysis is often recommended for assessing the impact, which may also use a variety of methods in this way one could use more than one measure to assess the impact. Using the available information, one can construct an "effect's table" or "effect's matrix" which can be used for comparing projects. The columns of the effect's table represent the alternative projects/ activities, and the rows represent the criteria by which the alternatives are evaluated.

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EVALUATION RESEARCH VS Research EVALUATION

Introduction

Evaluation research is the systematic application of social science research procedures in assessing the conceptualisation, design, implementation and utility of social intervention programs. In other words, evaluation research involves the use of social research methodologies to judge and improve the planning, monitoring, effectiveness and efficiency of interventions or programs on the target population.

In many instances regardless of their geographical location and sponsorship, interventions/ programs/ projects are misguided, misconceived, badly implemented and ineffective. In order to make sure that the anticipated interventions are effectively and efficiently implemented, one needs to answer a range of questions, such as:

- What are the nature and scope of the problem being addressed?
- What interventions are being undertaken to address the target problem?
- What is the appropriate target population for the intervention?
- Is the intervention being implemented as it was originally anticipated?
- Does the intervention in fact reach the target population?
- Is it effective?
- How much does it cost?
- What are its costs in relation to its effectiveness and benefits?

Providing answers to this type of questions is the heart of evaluation research.

Evaluation research is an integral part of a broader set of activities termed as program/project planning and implementation. Evaluation research must therefore be seen as just one of the many inputs into the conceptualisation, design and implementation of a program.

The practice of evaluation research involves the systematic collection of information about activities, characteristics and outcomes of programs, personnel and product, for use by specific people to reduce uncertainties, improve effectiveness to make decisions with regard to what those programs, personnel or products are doing and affecting. Thus, the term evaluation research emphasises a systematic collection of information about:

- Broad range of topics;
- For use by specific people; and
- For a variety of purposes.

In order to maximise their influence, the evaluator must understand the formal and informal organisational arrangements of the environment in which they work, the various stakeholders and their interests.

Evaluation

The term, evaluation, are defined differently by different authors. There are over fifty definitions in the literature (Patton 1982). With respect to the definition of evaluation it is important to keep in mind:

- No single definition will suffice fully to capture the practice of evaluation.
- Different definitions serve different purposes.
- There are fundamental disagreements within the field about the essence and boundaries of evaluation.
- In defining the term in any given situation find out the perceptions and definitions of the people with whom one is working.

For our purposes the term evaluation refers to a *systematic assessment of a situation at a given point in time whether that point is in the past, the present or future*. If the given point of time is in the past, then the assessments rely on actual measurements and observations. If the assessment is done for the future, then this will heavily rely on projections/expected outcomes. Evaluation also looks at several aspects of a project namely performances, quality, relevance and eventual impact.

The term evaluation may encompass:

- Program evaluation;

- Personnel evaluation;
- Policy evaluation;
- Product evaluation; and
- Institutional evaluation and other valuative processes or a combination of these sets.

Purpose of Evaluation

Evaluation may be undertaken for a variety of reasons. The various purposes are summarised in the following sections.

For Management and Administrative Purposes

Evaluations may be undertaken for management and administrative purposes to:

- Assess the appropriateness of program change;
- Increase the effectiveness of program management and administration, i.e., to identify ways to improve the delivery of interventions;
- Meet the various accountability requirements of funding groups and others; and
- Legitimisation of the program: Information on how well interventions are implemented, the extent to which they reach targets, their impacts and costs may help advocates of a particular program to ward off their adversaries or vice versa.

For Planning and Policy Purposes

Evaluations may be undertaken for planning and policy purposes to test innovative ideas and technology "appraisal," "priority setting" ex-ante evaluation. These may be used to decide whether to expand or curtail the program, and/or to support advocacy of one program as opposed to another.

For Methodological Development

Evaluations may be undertaken for methodological purposes to test a particular social science hypothesis or a professional practice principle.

Characteristics of Evaluation

At the early days, technical quality and accuracy were the primary concerns of researchers. Methodological rigor was the primary and often the only criterion by which evaluations were judged. Methodological rigor meant experimental design, quantitative data and detailed statistical and other analysis. Validity, reliability, measurability and generalisability were the dimensions that received the greatest attention in evaluation research proposals (Bernstein and Freeman 1975).

However, the evaluators found that the methodological rigor did not guarantee that findings would be used. As a result, utilisation of evaluation became a major concern. To be effective, an evaluation should be useful, feasible, accurate and practical. It should be practical in terms of availability of data, available time, costs as well as the administrative system. An evaluation should have the following four features:

- **Utility**: An evaluation should not be conducted at all it there is no prospect for it is being useful to some audience.
- **Feasibility**: It should not be done if it is not feasible to conduct it in political terms, or practicality terms or cost effectiveness terms.
- **Propriety**: It should not be done if one cannot demonstrate that it will be conducted fairly and ethically.
- **Accuracy**: It should be reasonably accurate, given the data and the tools available. Should be useful the findings should be accurate.

If we can demonstrate that it will be conducted fairly, ethically, will have utility, will be feasible, then one could turn to the difficult matters of technical adequacy of evaluation.

Implementation of a utility focused, feasibility conscious propriety oriented, and accuracy-based approach to evaluation research will require:

- Situational responsiveness;
- Methodological flexibility;

- Multiple evaluators' role;
- Political sophistication; and
- Substantial doses of creativity (Patton 1982).

Therefore the challenge for an evaluator is to work actively - reactively - adaptively with a group of decision makers in a consultative fashion to design and implement an evaluation that is responsive, useful, accurate, understandable and practical.

Evaluation Processes and Content

An evaluation process refers to the way evaluation is conducted. This deals with questions such as:

- Who is involved in the evaluation?
- How much it costs?
- How the evaluation is introduced into the program?
- The timeliness involved; and
- How feedback from evaluation is handled, etc.?

Standards that apply to evaluation processes are feasibility (do-able) and propriety. Thus, an evaluation process must be feasible, and the evaluator should behave with propriety. A practical evaluation process is doable, manageable, understandable, feasible and applicable within a given context.

The term evaluation content refers to the findings of a particular evaluation. This includes:

- The data collected;
- Interpretations made;
- Recommendations offered; and
- Limitations of the process, etc.

The standards that apply to the content of evaluation are in the criteria related to utility and accuracy.

Note: the priority in evaluation is on producing practical knowledge, i.e., knowledge that can be used to do something. The information should be informative, timely and influential. These standards require evaluators to acquaint themselves with their audiences, ascertain audience's information needs, and report the relevant information clearly and when it is needed.

One should aim for practical processes that yield practical findings. Do-ability is a necessary condition but not sufficient condition for utility. Impractical processes can sometimes produce some valuable information. Feasibility of implementation is no guarantee that practical findings will be generated.

Judgement about the relative practicability of a particular evaluation process in evaluation findings can only be made with reference to a particular situation involving specific people, specific program and specific constraints.

One has to remember that there are probably relatively few instances where decisions are made solely on evaluation findings. However, if they are strong enough and the studies are defensible from the standpoint of rigor and thoroughness, they may dominate decision-making. Concern for how specific decision makers will use valuative information should be the driving force in an evaluation, i.e., evaluation processes should be user and utilisation focused.

Situational responsiveness is imperative for effective and moral evaluation practice. Effective evaluators must be prepared to play multiple roles to be alternatively scientists, program consultants, group facilitators, keen observers, statisticians, project administrators, diplomat, politicians, writers, entertainers and teachers to name only a few common roles. Evaluation should be as objective as possible - one that would be unchanged if the evaluations were replicated by the same evaluators or conducted by another group.

The scope of each evaluation, of course, depends on the specific purpose for which it is being conducted. The aim of all evaluations is to provide the most valid and reliable findings possible within political and ethical constraints and the limitations imposed by time, money and human resources.

Evaluation of Research and Research Systems

Evaluation of research deals with the research products, whereas the evaluation of research system deals with the entire system, its organisational, administrative, financial and personnel components as well as its research contents, i.e., research processes and products. Research products can be classified into knowledge in:

- Embodied technologies, e.g., seed;
- Disembodied technologies, e.g., cultural practices;
- Research results, e.g., papers/publications; and
- Specialised information, e.g., methodologies/policies (Raina & Kristnan-Marg, 1995).

The clientele for this range of research products is specialised, each group of clients having an exclusive claim to direct relevance or value to other clients. Evaluation of research products and the choice of methodology for it, thus, depend on the nature of the research product, i.e., a published paper or a new variety or a modification of planting methods, as well as the particularity the clients. This particularity of the clients will also determine "what" is being evaluated, i.e., the research product, the process, the personnel (to ensure accountability of scientists). The question is "accountability to who?"; "Which client groups?"; or the overall organisation of the research.

The organisational performance depends on: the environment; organisational capacity; and organisational motivation (see Chapter 28). However, this is not the focus of this chapter.

Classes of Evaluation Research

There are three classes of evaluation research. These are:

- Analysis related to the conceptualisation and design of interventions;
- Analysis related to monitoring and accounting of program evaluation; and
- Analysis related to assessment of program utility.

Evaluation of most programs needs to include all three classes of activities. An evaluation that includes all these classes of activities is referred to as a "comprehensive evaluation." The three classes of evaluation research and the activities involved are discussed in following sections.

Program conceptualisation and design

The origin of a program/project is the recognition of a problem. Program conceptualisation and design questions are:

- What are the extent and distribution of the target problem and/or population?
- Is the program designed in conformity with intended goals? Is there a coherent rationale underlying it? Have chances of successful delivery been maximised?
- What are the projected or existing costs and what is their relation to benefits and effectiveness?

Monitoring and accountability of program implementation

There are several reasons for monitoring programs including:

- Accountability. Proper management and administration of programs require empirical evidence that what presumably was paid for and deemed desirable was virtually undertaken.
- There is no point in being concerned with the impact or outcome of a particular project unless it did, indeed, take place and served the appropriate participants in the way intended.

Many programs are not implemented and executed according to their original design. Possible causes are:

- Personnel are simply not available, inadequate, non-cooperative;
- Equipment is in repair;
- Project staff may be prevented by political or other reasons;
- Staff may not have the motivation or know how; and
- Prior budget estimates or inflation leads program staff to modify their efforts.

Monitoring can provide a systematic assessment of whether or not a program is operating in conformity to its design and reaching its specified target population. Program monitoring questions include:

- Is the program reaching the specified target population or target area?
- Are the intervention efforts implemented as originally planned?

Accountability Studies

The term accountability refers to obligation to report, explain or justify something within the research context the responsibility of an organisation or its staff to provide evidence of research expenditure and performance to public, policy makers, donors as well as higher level management. Accountability is becoming increasingly important in both national and international projects. One could look for six different types of accountability.

Types of accountability:

- Impact Accountability. Program managers are concerned with impact, both for internal operating reasons and in order to justify programs externally.
- Coverage Accountability. The number and characteristics of the targets, the extent of penetration (what proportion of the potential targets are served), drop out rates, etc.
- Service Delivery Accountability. To assess how the actual operation of a program conforms to program plans.
- Efficiency Accountability. Judging relative benefits and effectiveness against cost of different program elements.
- Fiscal Accountability. Accounts for use of funds.
- Legal Accountability. All programs, public and private sectors, require commitments in order to meet legal responsibilities. In public and donor-funded programs, adequate compliance with legal requirements is often a prerequisite for continued funding.

In developing accountability strategies, there are two important considerations that need to be addressed:

- Continuous versus cross sectional evaluations; and
- Internal versus external assessments.

Continuous Versus Cross-Sectional Evaluations

Many large programs employ monitoring and information systems, often referred to as management information systems (MIS), that allow them to assess on an on-going basis the work and results of their programs. Since they do represent a permanent commitment of resources, they need to be justified by constant use.

Individual, or cross sectional studies undertaken from time-to-time, may be expensive. They may not be perceived as part of a routine operation. If not completed in time (may not be timely) and may have less utility for day-to-day administrative decisions.

There is no way to provide guidance on this issue. One may use a mix of continual monitoring to assess progress, and cross sectional evaluations to estimate at various points their impact, costs, and benefits.

Internal Versus External Evaluations

Accountability evaluations raise sharply the issues of whether programs should undertake their own evaluations or contract with outsiders to do so. The benefit of internal evaluation is that the evaluator will know a great deal about the program operations. The greatest disadvantage is that the outsiders may be suspicious of the authenticity of findings.

Assessment of program utility

An assessment of program utility attempts to know both the degree to which a program has had an impact and its benefits in relation to costs. The former is referred to as the program's effectiveness and the latter as its efficiency. Unless programs have a demonstrated impact, it is hard to defend their implementation and continuation. Hence, the basis and need for impact evaluation. But knowledge of effectiveness is simply insufficient in most cases. Outcome or impact must be judged against input costs. Since programs may not be supportable because of their high costs in comparison to their impact, the need to determine the relationship of costs to effectiveness necessitates efficiency assessments.

Impact Assessment: Effectiveness Assessment

An effectiveness assessment gauges the extent to which a program causes change in the desired direction in the target population. It implies that there is a set of specified operationally defined goal and objectives, and criteria of success. A program that has impact is one that achieves some movement or change toward the desired objective.

To conduct an impact evaluation, the evaluator needs a plan for data collection in order to demonstrate in a persuasive way that the changes are a function of the intervention and cannot be accounted for in any other ways, i.e., there must be a control group and an experimental group.

Efficiency Assessment

Projects/interventions compete with each other for funds and resources from foundations, international organisations and the various levels of government. Choices must continually be made between funding and not funding, continuity or discontinuity, and expanding or contracting one program as opposed to another. Efficiency assessments provide a framework of reference for relating costs and program results. The latter measured either in monetary terms or in terms of actual outcomes. In simplest terms, an intervention is efficient if its benefits are greater than its costs.

Efficiency analysis can be considered as an extension of effectiveness assessment, but not as an alternative. It is senseless to perform efficiency analysis for ineffective programs, i.e., impacts are unknown or un-estimateble. Efficiency assessment is appropriate at two pivotal points:

- Planning and design phases, i.e., ex-ante, on the basis of anticipated costs and benefits; and
- Impact assessment phase, ex-post, to assess whether the cost of the intervention can be justified by the magnitude of outcomes.

Cost - benefit or cost effectiveness analysis could be used to assess efficiency. Steps in conducting a cost - benefit or cost effectiveness analysis includes:

- Estimating costs - both direct and indirect;
- Estimating benefits - both tangible and intangible;
- Translation into common measure usually a monetary unit; and
- Comparison of the costs and benefits.

Some considerations that go with such choices concern economics. Is the program producing sufficient benefits for the costs incurred? Is it intended to produce a particular benefit at a lower cost per unit of outcome than other interventions or are delivery systems designed to achieve the same goal?

Program Utility Questions

Assessment of program utility attempts to answer the following questions:

- Is the program effective in achieving its intended goals?
- Can the results of the program be explained by some alternative process that does not include the program?
- Is the program having some effects that were not intended?
- What are the costs to deliver services and benefits to program participants?
- Is the program an efficient use of resources, compared with alternative uses of the resources?

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OVERVIEW OF EVALUATION ACTIVITIES

Introduction

One of the factors that determine the level of efforts and technical procedure undertaken during the evaluation is the state of the program's development. Possible states are:

- Innovative;
- Established;
- Those in need of "refinement," "modification," or fine-tuning.

In addition, the purpose and the interest of the stakeholders will also determine the activities involved. It is important to note that there is no clear cut dividing point between innovative and fine-tuning or modification efforts. The key features of these three types of evaluation are outlined in this chapter.

Categories of Project Evaluation

Depending on the 'state' of the programme, the evaluation activities may differ. Based on the state, one could identify three types of evaluations.

Evaluation of innovative projects

Completely new interventions are relatively rare. "Innovative" in this context means that the "treatment" has never been applied to the population specified. It may have been tried as a small scale demonstration, but never with the realistic intent of having it implemented on a broad scale. Programs are considered innovative if:

- The intervention itself is still in the emerging stage or the research development phase. In other words, there is no or very little/limited evidence that it has an impact as an installed program.
- The delivery system or parts of it have not been tested.
- The targets of the program are markedly new or expanded.
- A program originally undertaken in response to one goal is continued or expanded because of its impact on another objective.

Evaluation for fine tuning of projects

Once programs are underway, it is often important to test variations in the way they operate. The major reasons for fine-tuning are:

- To improve their efficiency, i.e., either to increase the magnitude of their impact or to decrease their costs per unit of impact;
- To provide equitable service delivery.

Evaluation of established programs

There are several reasons for evaluating established programs. These are:

- To justify its continuation, expansion, or termination to have hard data on its impact and the ratio of benefits to costs.
- To provide evidence of, or suspicion that programs are either ineffective or inefficient.
- To cover "sunset regulations" which provide for regular program reviews and "automatic" termination of programs failing to demonstrate utility.

Setting goals and specifying objectives require some assumptions or knowledge about two fundamental aspects of the social situation: values and existing conditions.

Innovative Evaluation Activities

Innovative evaluation activities require that an evaluator in planning, designing and testing programs must be capable of undertaking a wide range of activities.

Operationalising objectives for the program

Goal setting must lead to the operationalisation of the desired outcome - a statement that specifies the condition to be dealt with and establishes a criterion of success. The operationalised statements are termed objectives. Goals are often set in broad and rather vague terms. Goals are based on the assumption that there is room for improvement - that is there is discrepancy between the actual conditions and those specified by goals. Goals are statements, usually general and abstract of the desired state. Objectives, on the other hand, are specific and operational statements regarding the desired accomplishments.

Objectives can be abstract, e.g., eradication of poverty, or relative, e.g., reducing of poverty by 50 percent. It is essential that evaluators, planners, program staff, and sponsors agree on the criteria to be used in assessing whether or not the objectives have been achieved. If resource's permit/are available, include multiple criteria that reflect the interests of the various parties involved. Goal attainment scaling is essential to account for reality.

Although most evaluations rely on statements of objectives that involve measuring change in the target population/group as a whole, goal attainment scaling makes it possible to tailor goals to individual units within the target population. The result can be summarised to provide a composite estimate of program impact.

Developing an Impact/Intervention Model

In order to undertake a successful evaluation, both explicit agreed upon objectives and detailed descriptions of how they are to be achieved are required. An impact model is a set of guiding hypothesis underlying the planning and implementation of a program. An impact model attempts to develop a set of hypotheses on which action can be based. The model often consists of nothing more than the assumptions underlying a program's operation. The impact model takes the form of a statement about the expected relationships between the program and its goals. It sets forth the strategy for closing the gap between the goal set during the planning process and the existing condition. It must contain:

- A causal hypothesis;
- A hypothesis about intervention; and
- An action hypothesis.

Casual Hypothesis

A causal hypothesis is what determines the condition that the program seeks to modify. Specify the causal variables in operationally measurable terms.

An Intervention Hypothesis

An intervention hypothesis is a statement that specifies the relationship between the program, i.e., what is going to be done and the process as associated in the causal hypothesis with the behaviour or condition to be changed. It should be consistent with the causal hypothesis.

An Action Hypothesis

An action hypothesis is necessary in order to assess whether the intervention is necessarily linked to the outcome, that is, the behaviour or condition that one is seeking to modify. Intervention/impact models must specify intervention variables. Thus, one must avoid selecting interventions with low feasibility. There must be program acceptance by targeted sponsors and other stakeholders and the intervention should not have undesirable side effects.

Defining the target population

Defining the target population is a strategic decision, could be political and it is often desirable to distinguish between the group that will be immediately subjected to an intervention (the direct targets) and the whole population that eventually requires attention (the indirect target).

Designing a delivery system

Interventions, no matter how well conceived, cannot be effective and efficient unless there are carefully developed delivery systems. The following issues must be addressed:

- Identification of the target problem and population;
- Procedures and services provided;

- Qualification and competencies of staff;
- Mechanisms for recruiting and obtaining the cooperation of targets;
- Means of optimising access to the intervention, including location and physical characteristics of service delivery sites; and
- Follow up effort.

Assessing impact and estimating efficiency

Pre-testing of evaluation procedures - pilot studies. A "dummy table" which shows what the results of an evaluation may look like into which a range of utilisation and impact estimates can be inserted. Thus, dummy tables may alert staff, sponsors, and evaluators to whether or not appropriate evaluation questions are being asked.

Summary of Innovative Evaluation Activities

An evaluator must be capable, in planning, designing and testing programs, of undertaking a wide range of activities. For example:

- Identifying and describing the problem or concern;
- Operationalising objectives for the program;
- Developing an intervention model;
- Defining a target population;
- Designing a delivery system and procedures for monitoring it; and
- Assessing impact and estimating efficiency.

Fine-Tuning Established Programs

As mentioned earlier, the division of innovative programs and fine-tuning is not a very clear cut one. Often there is overlap. Program managers, on the basis of on-going evaluation information, may make day-to-day administrative and technical changes that are quite extensive and are subject to systematic evaluation. Program fine-tuning typically occurs because program sponsors and staff are dissatisfied with either the effectiveness or the efficiency of their interventions or both. The basis for implementing such changes may be the findings of systematic evaluation studies of a monitoring or impact type.

Fine-tuning basically requires three related sets of activities: *reappraising objectives and outcomes, reputability assessments, and program re-planning and redesign*. These are discussed below.

Re-appraising objectives and outcomes

Fine-tuning efforts are a response to existing conditions. Often, there is an awareness that a program failed to meet expectations. This may require some modification of the program's objectives and outcome criteria. Sometimes, redefinition of objectives stems from:

- The dialogue that almost invariably accompanies administrative and day-to-day working activities;
- Evaluators may undertake special studies, either as independent contractors or as staff members to obtain data to aid program personnel in revising objectives; and
- Evaluators and program staff have at their disposal ongoing management and service information systems that provide data on issues surrounding current objectives and the extent to which they are being met.

Reputability assessments

Reputability assessment refers to systematic efforts to obtain from relevant stakeholders, particularly targets, opinions and experimental data on which to judge the extent of a program's success in meeting its objectives. These assessments often consist of obtaining market research data, and may involve some questionnaires to clients.

Often reputability assessments will point to fine-tuning efforts that are comparatively simple or sometimes, the information may highlight the need for considerable program modification. When systematic reputability assessments are conducted in advance of these pressures, program management may be able to fine-tune interventions and avoid becoming subject to public harassment.

Program re-planning and re-design

Implementing refinements and fine-tuning may require a return to various steps in the planning process. It is necessary that the problem be well defined and described, the objectives are operationalised, a revised impact model is developed, the target population is redefined, the delivery system is redesigned, and plans are made for whatever revisions are required in monitoring impact and efficiency. In terms of fine-tuning, then, the evaluator is involved in the following tasks:

- Reappraising objectives;
- Using data from previous evaluations, as well as information about program progress gathered as part of the service delivery, in order to seek out ways of modifying programs;
- Undertaking and using reputability assessments;
- Participating in program re-planning and design; and
- Planning and implementing evaluation designs to monitor the program changes and their impact.

Note: evaluations must be tailored to the programs. It is important to recognise that programs and evaluations are "dynamic" in the sense that additional program experience, preliminary evaluation feed back, and shifts in the political, economic and social contacts in which programs and evaluations occur may require modification and adjustment to evaluation designs.

Evaluating Established Programs

While the evaluation of innovative programs represents an important activity for the field, by far the greater proportion of program resources, and thus evaluation efforts, go into the assessment of established are on-going programs. More are conducted "in-house" by staff concerned/connected with operating agencies. Part of the evaluation of established programs is associated with the managerial concerns of maintaining and informing programs effectiveness and efficiency. Spiralling costs of programs and increased resource restraints particularly of public funds, require that we choose what to support and in what magnitude.

The evaluability perspective

Sometimes it is difficult or impossible, to implement evaluations of public programs because managers and other stakeholder resisted, were uncooperative, or failed to grasp the purpose of the studies. Thus, too frequently evaluation results were not used to refine and modify programs. Sometimes it is suggested that an evaluability assessment should precede any typical evaluation effort.

Evaluability assessments

This includes a number of steps

Preparing a Program Description

The program description is based on formal documents such as funding proposals, published brochures, administrative manuals, annual reports, minutes and completed evaluation studies. It aims to identify program objectives and program components or elements.

Interviewing Program Personnel

Key people are interviewed to gather descriptions of the program's goals and rationale as well as to identify actual program operations. Intention and actual operations are developed and subsequently verified.

Scouting the Program

Scouting the program is accomplished through site visits to obtain first-hand impressions of how programs actually operate.

Developing an Evaluable Program Model

From the various types of information, the program elements and objectives to be considered for inclusion in evaluation plans are explicitly identified.

Identifying Evaluation Users

The purposes of evaluation activities and key stakeholders to whom they are to be directed are next identified.

Achieving Agreement to Proceed

Achieving an agreement to proceed with the evaluation involves reviewing the evaluation plan with the various stakeholders. The process of information collection typically includes dialogue with key individuals and groups. These groups and stakeholders must agree on the following:

- Program components to be analysed, the design of the evaluation, and priorities for undertaking the work;
- Commitment of required resources and agreements on necessary cooperation and collaboration; and
- A plan for utilization of the evaluation results.

Key Differences

Primary key differences between these forms of evaluation arise from the increased emphasis on existing/ongoing activities in designing program evaluation model. In addition, there is much more deliberate attention to stakeholder' views, and responsibilities.

***Note*:** The first rule in evaluations is that an evaluation begins when a program is being designed by setting up clear objectives for the program by selecting specific verifiable indicators of achievement for that program, and by specifying how the achievement will be measured. The benefits of this exercise are of two fold:

- It forces the program designers to clearly express what the objectives of the programs are and what results are expected in very concrete terms - to make sure that the program is appropriate and realistic; and
- It requires specifying how progress and achievements will be measured and therefore establishes the basis for monitoring and reporting procedures.

The various activities involved in the three types of evaluations discussed are summarised in Table 14.1.

Table 14.1:Activities Involved in the Three Types of Evaluations

	Innovative Programs	Established Programs	Fine-Tuning
Conceptualising	• Problem description; • Operationalising objectives; • Developing intervention model; • Defining extent and distribution of target population; • Specifying delivery system.	• Determining evaluability; • Developing evaluation model; • Identifying potential modification opportunities; • Determining accountability requirements.	• Identifying needed program changes; • Redefining objectives; • Designing program modifications.
Implementing	• Formative research and development; • Implementation monitoring.	• Program monitoring and accountability studies.	• R&D program refinements; • Monitoring program changes.
Assessing	• Impact studies; • Efficiency analyses.	• Impact studies; • Efficiency analyses.	• Impact studies; • Efficiency analyses.

KEY REFERENCES

Rossi, P.H., AND H.E. Freeman, (1982). *Evaluation: A Systematic Approach*. (5^{th} Ed) Beverely Hills, CA: Sage Publications.

Patton, M.Q, (1997). *Qualitative Evaluation and Research Methods*. (3rd Ed.) Thousand Oaks, CA: Sage Publications.

UTILIZATION FOCUSSED EVALUATION

Introduction

Utilization occurs when there are *immediate, concrete* and *observable* effects on specific decisions and program activities resulting directly from evaluation research findings. The extent of utilization of findings of an evaluation depends on who participated in the evaluation process, and the questions addressed in the evaluation, i.e., the focus and quality of the process.

Utilization focussed evaluation differs from other evaluation methods in that the evaluator alone does not carry the burden for choices about nature, purpose, content and methods. Utilization focussed evaluation combines style and substance, activism and science, personal perspectives and systematic information. Working alone increases enormously the likelihood that the evaluation will answer the wrong questions, be misunderstood, misused, under utilized or altogether ignored. *In utilization focussed evaluation one has to plan the utilization before data are ever collected.* One has to remember the primary purpose of evaluation research is to gather data that can be used to make judgements about program effectiveness.

Steps in Utilization Focussed Evaluation

The various steps involved in utilization focussed evaluation are summarised in Figure 15.1 and are discussed below.

STEP 1: Identification of relevant decision makers, information users and stakeholders

A user focussed evaluation is based on the identification and organisation of relevant decision makers and information users. Basically one has to ask two questions:

- Who will make decisions about the evaluation process? and
- Who will use the information that the evaluation produces?

The personal factor is very important. The people and not the organisation use the findings. Therefore, the evaluation must be responsive to their needs. The personal factor refers to the presence of an identifiable individual or group of people who personally cared about the evaluation and the information it gathered. It represents the following specific factors in individuals or people:

- Leadership;
- Interest;
- Enthusiasm;
- Determination;
- Commitment;
- Aggressiveness; and
- Caring.

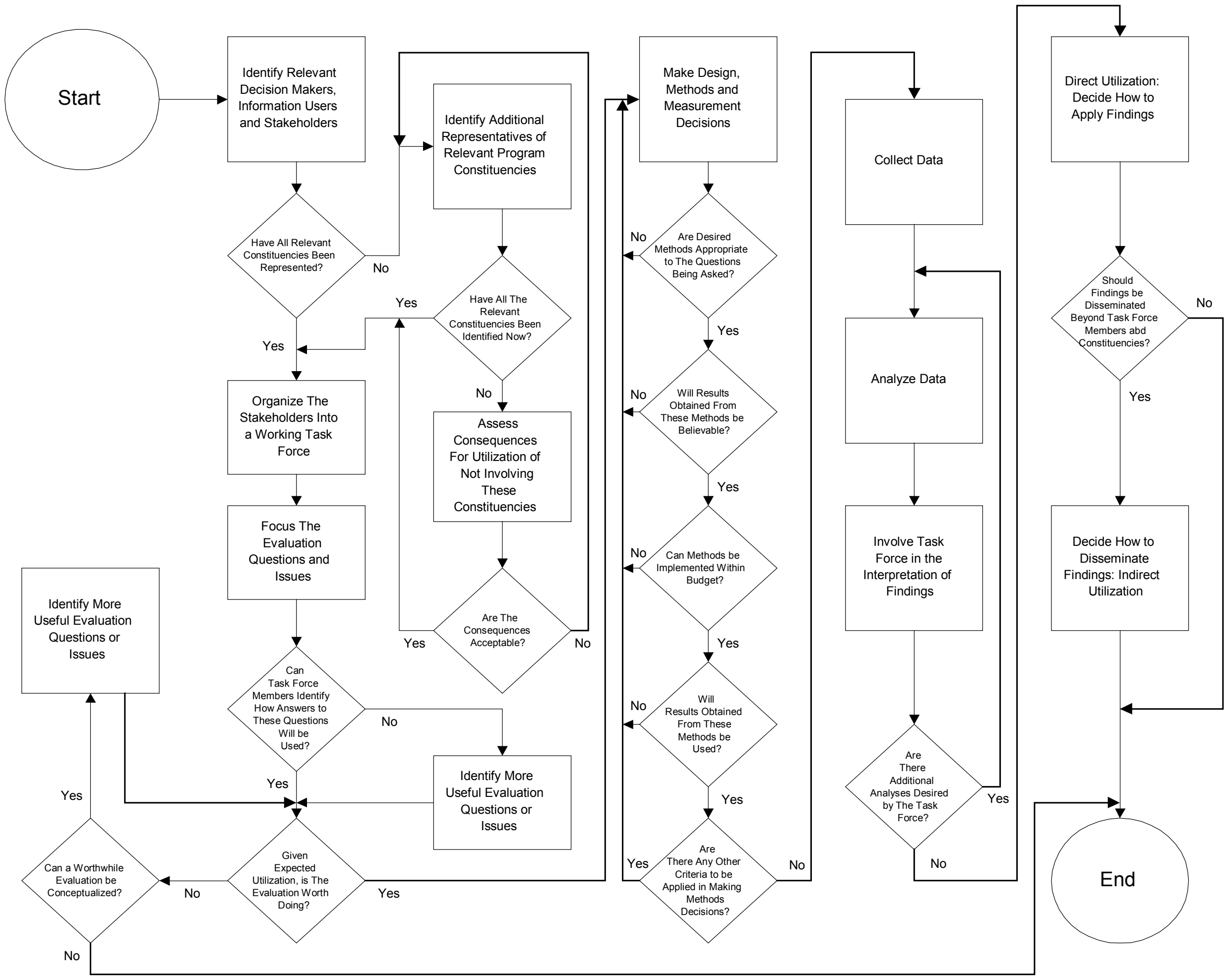
The criteria for identifying personal factors are:

- People who can use information;
- People to whom information makes a difference;
- People with questions they want answered;
- People who care about and are willing to share responsibility of evaluation and its utilisation.

The criteria for organisation are:

- Continuous direct contact between evaluators, decision makers, and information users;
- Organise a small group that is active, hard working and decision oriented; and
- Members of a group who are prepared to commit a lot of time and effort to the evaluation process.

Figure 15.1: Steps in Utilisation Focussed Evaluation



Source: Patton (1982)

STEP 2: Identifying relevant evaluation issues and questions

Once the relevant decision makers are identified, the evaluator works with them to focus on relevant evaluation questions.

Criterions for Formulating Queries

An evaluator can use the following criteria:

- Is it possible to bring data to bear on the question? Utilization focussed evaluation questions are empirical questions, i.e., it is possible to bring data to bear on them and then to ensure that answer is not predetermined by the phrasing of the question?
- Identify questions decision makers want answered or are interested in.
- Identify questions that need answering. This could be lack of information or knowledge required to answer the question.
- Identify the personal interest criterion; and
- Identify questions required for follow-up action.

Evaluation questions should be focussed on the basis of program mission statement, goals and objectives. They should be framed on the basis of the time when evaluation was done. Therefore, the state of program development is important. In addition the evaluation questions should be framed in the context of the organisational dynamics of the program.

STEP 3: Choice of methods and measurement decisions

Once questions are focussed on relevant issues, decisions for methods are made with special attention to:

- Appropriateness;
- Believability;
- Feasibility (in terms of cost and time); and
- Data utility.

STEP 4: Data collection

At this stage data collection starts. Various methods, or a combination of methods, are often used for data collection.

STEP 5: Data analysis and feedback

This step involves analysis of data and getting feedback of findings. It is important for the evaluator to ensure that decision makers and information users are included in analysis, interpretation and dissemination of findings, as well as in the planning for further utilization processes. It involves:

- Separation of data analysis from data interpretation to avoid biases that the evaluator's conclusion introduces;
- Presentation of data analysis results in a form that makes sense to decision makers and information users to avoid surprises;
- Evaluators working with decision makers and information users to make full use of the data;
- Evaluators working with the decision makers and information users to develop specific plans for action and utilization on the basis of evaluation findings and interpretation;
- Utility focussed data analysis and data interpretation that includes judgements, conclusions and recommendations of both evaluator's and decision makers;
- Evaluators and decision makers negotiating and co-operating in the dissemination efforts; and
- Throughout the dissemination effort both evaluators and decision makers taking responsibility for the evaluation (from conceptualisation to recommendation).

Summary of Steps in a Utilization Focussed Evaluation

The key steps in the process are:

- Identify decision makers;
- Focus evaluation questions;
- Gather data; and
- Analyse the data and feedback findings.

The realities of evaluation practice are time constraints and limited resources. This should be reflected by taking into consideration the following points:

- The evaluation process should be user and utilization focussed.
- Situational responsiveness is imperative for effective and moral evaluation practices.
- An effective evaluator must be prepared to play multiple roles.
- The evaluation should be as objective as possible
- The scope of each evaluation depends on the specific purpose for which it is being conducted.
- The aim of all evaluation is to provide the most *valid* and *reliable finding* possible within *political* and *ethical constraints* and the limitations imposed by *time, money* and *human resources.*

KEY REFERENCES

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PARTICIPATORY EVALUATION

Introduction

The past two decades, have seen an increased recognition of the importance of participation by beneficiaries and a wide range of other stakeholder in decision making. Experience has shown that participation improves the quality, effectiveness and sustainability of development actions. By placing people at the centre of such actions, development efforts have a much greater potential to empower and lead to ownership of the result. For those involved specifically with evaluation, there has been a growing dissatisfaction with conventional modes of assessment that claim to be scientifically neutral and unbiased yet have had very little impact on how development activities are carried out. This has lead to the various participatory approaches, tools and methods

Participatory evaluation involves the stakeholders and beneficiaries of a program or a project in the collective examination and assessment of the program or project. The evolution of participatory evaluation is summarised in Box 16.1. Participatory evaluation is people centred: project stakeholders and beneficiaries are the key actors of the evaluation process and not the mere objects of evaluation.

Box 16.1: Evolution of the Evaluation Process

The evaluation process since its inception has gone through different stages. Guba and Lincoln (1981) call the participatory evaluation as the Fourth Generation Evaluation.

First generation evaluation emerged in the 1900s and characterised as measurement oriented, associated with the scientific management movement in the business and industry. The role of the evaluator was technical, providing tools and instruments for measurement – student performance assessment and time and motion studies.

Second generation evaluation concentrated more on descriptions and led to program evaluations. It focussed beyond measurement and dealt more on the achievement of objectives and analysis of strengths and weaknesses. The role of the evaluator went beyond the technical to include that of describer.

The third generation evaluation was characterised by efforts to include judgement as an integral part of evaluation. Thus the evaluators also became judges.

The fourth generation evaluation refers to the most recent evolution in evaluation practice and involves negotiations. It incorporates stakeholders more centrally into the evaluation process by taking into account their claims, concerns and issues. They embrace a more qualitative approach to evaluation. The evaluator becomes facilitator of the negotiation process with stakeholders who participate in designing implementing and interpreting the evaluation. Stakeholders are not viewed as subject of experiment or object of study, but rather as participants in the evaluation process.

Participatory evaluation is reflective, action oriented and seeks to build capacity by:

- Providing stakeholders and beneficiaries with the opportunity to reflect on a project progress and obstacles.
- Generating knowledge that result in the application of lessons learned and leads to corrective action and/or improvement.
- Providing beneficiaries and stakeholders with the tools to transform their environment.

Participatory evaluation is context-specific, rooted in the concerns, interests and problems of program end-users. The end-users immediate reality is what charts the route and determines the evaluator's purpose and direction. Flexibility is the key word in participatory evaluation. Choices must be made about the degree to which end-users can realistically participate in the process

Functions of participatory evaluation

Participatory evaluation serves four key functions, some of which concerns the stakeholders and beneficiaries while others relate to the funding agencies.

1. It helps to build the capacity of stakeholders to reflect analyse and take action – such analysis should occur throughout the life of the project.
2. It can contribute to the development of lessons learned that can lead to corrective action or improvement by project recipients – when project stakeholders are involved in analysing problems, constraints and obstacles, they can often propose solutions.
3. It can provide feed back for lessons learned that can help program staff to improve program implementation. A participatory evaluation not only looks into the past but also guides into the future.
4. It helps to ensure accountability to stakeholders, managers and donors by furnishing information on the degree to which project objectives have been met and how resources have been used.

The focus on lessons learned is an essential dimension of participatory evaluation. Such evaluations should help to guide projects into the future by giving stakeholders the tools with which to take corrective action. In addition lessons learned should provide donors with the insight and tools to improve program delivery and management.

Participatory evaluation may take place during the course of a project (usually at its mid point) towards or at the end or a significant amount of time (e.g. 2 years) after a project has been completed. Undertaking an evaluation at mid-point offers several advantages. It presents an opportunity to take stock of a project's progress to date, its achievements and any obstacles encountered. Lessons learned can be applied and corrective action can be taken if necessary. Since mid-term evaluations are forward looking, they can provide stakeholders with the tools to take different source of action.

Key characteristics of a participatory evaluation

The following are the key features of a participatory evaluation

- It draws on local resources and capabilities;
- Recognise the innate wisdom and knowledge of end users ;
- Demonstrates that end-users are creative and knowledgeable about their environment;
- Ensures that stakeholders are part of the decision making process; and
- uses facilitators who act as catalysts and who assist stakeholders in asking key questions.

At the heart of participatory monitoring and evaluation (PM&E) however, are four broad principles:

► ***Participation*** – which means opening up the design of the process to include those most directly affected and agreeing to analyse data together?

► ***Inclusiveness*** – the inclusiveness of participatory M&E requires negotiation to reach agreement about what will be monitored or evaluated; how and when data will be collected and analysed, what the data actually means, and how findings will be shared, and action taken.

► ***Learning*** – the process leads to 'learning' which becomes the basis for subsequent improvement and corrective action.

► ***Flexibility*** – since the number, role and skills of shareholders and external environment and other factors change over time flexibility essential.

The characteristics of participatory evaluation are participation and collaboration, a problem-solving orientation, knowledge generating, creativity releasing, using multiple methods, experts involved as facilitators, and using participatory evaluation.

Participation and Collaboration

In the evaluation process collaboration ensures the participation of all those affected by project decisions. This includes beneficiaries as well as program and project staff. Special efforts are made to ensure meaningful participation women, junior project staff as well as extension workers are involved in the process.

Problem Solving Orientation

The driving force behind participatory evaluation is not accountability to outsiders, but development at the local level. Participatory evaluation becomes a process whereby the participants in a development project are empowered to learn and take effective action in solving problems.

Generating knowledge

Participatory evaluation aims to generate knowledge among local people at the community and project level. When users are actively involved in data collection processes, information becomes transformed into knowledge and leads to self-sustained action.

Releasing Creativity

Participatory methods are creative and learning in this environment builds self-esteem and confidence essential for initial action.

Using Multiple Methods

Validity and reliability are achieved through the use of multiple methods, and by including different users and stakeholders in community building. If available tools are considered inappropriate, new tools are created.

Involving Experts as Facilitators

If evaluation expertise is not available within the community, then an external expert is included to facilitate shared decision-making throughout the entire process of participatory evaluation. The task of the facilitator is to share ideas, help people consider options, and let the process be taken over as far as possible by users, community people and project staff.

It is important to note that:

- To be effective, participatory approaches require significant time and flexibility in order to account for unexpected events;
- Participatory approaches still call outside expert advice. Outsiders have recognised their limitation in performing participatory evaluation;
- Programs or projects that provide indirect benefits to the community may be more difficult to do in a participatory sense than direct benefit projects;
- Participation and participatory approaches are particularly desirable strategy in the case of projects with a broad client base and/or direct delivery to individual beneficiaries and researchers;
- Participation and participatory strategies work best when evaluators have inside knowledge of program and geographic locales in which program/evaluation is being carried out; and
- A participatory evaluation approach still benefits from expert input from those knowledgeable about the program sector, and evaluation theory and practice. The evaluation professional must continue to give advice on evaluation approaches and past experience in participatory evaluation.

Participatory evaluation and conventional evaluation

The key differences between participatory evaluation and conventional evaluation are summarised in Table 16.1. The conventional evaluation in most cases donor focussed and donor driven. Donors are the key clients, provide the financial support and contribute significantly in defining the terms of references (ToR). Very often evaluation is carried out more to fulfil a management or accountability requirement than to respond to project needs. An outside expert/evaluator or team is hired to conduct the evaluation. The evaluators collect the data, review the project or program and prepare a report. In most cases, stakeholders or beneficiaries play a passive role, providing information but not participating in the evaluation itself. The process can be considered more linear, with little or no feedback to project.

Table 16.1: Participatory M&E and Conventional M&E

	Conventional M&E	Participatory M&E
• Who plans and manages the process	Senior manager or outside expert	Local people, project staff, managers and outside stakeholders often helped by a facilitator
• Role of primary stakeholders and intended beneficiaries	Provide information only	Design and adopt the methodology, collect and analyse data, share findings and link them to action
• How success is measured	Externally defined, mainly quantitative indicators	Internally defined indicators including more qualitative judgement
• Approach	Pre-determined	Adaptive
• Defining terms of reference	Largely donors and managers	Stakeholders including beneficiaries
• Question makers	Largely managers and donors	Stakeholders
• Evaluator/Evaluation team	Mostly outsiders	Mix of outsiders and beneficiaries
• Process	Linear with little or no feed back	Two way flow of information
• Purpose	Management/accountability requirement	Build capacity of stakeholders & management/ accountability requirement
• Role of the evaluator	Plays the lead role	Act as facilitator
• Method	Reliance heavily on quantitative methods	Relies heavily on interactive qualitative methods but does not disregard quantitative tools

Source: Cummings (1995)

In a participatory evaluation, the role and purpose of evaluation change dramatically. Such an evaluation places a much (if not more) emphasis on the process, as on the final product the report. The purpose of the evaluation is not only to fulfil a bureaucratic requirement but also to develop the capacity of stakeholders to assessment and take action. Stakeholders and beneficiaries do more than providing information. They also decide on ToR, conduct research, analyse findings and make recommendations. The evaluator in conventional evaluations becomes more of a facilitator in participatory evaluation – guiding the process at critical stages and consolidating the final report based on the findings of the stakeholders.

Participatory evaluation recognises the wide range of knowledge, values and concerns of stakeholders and acknowledges that these should be the litmus test to assess and then guide the project performance. Participatory approaches to evaluation have the capacity to empower recipients. The active participation of stakeholders can result in new knowledge or a better understanding of their environment. It is this new knowledge and understanding that can enable them to make changes they themselves have discovered or advocated. As a result of active involvement of stakeholders in reflection, assessment and action, a sense of ownership is created, capacities are built, beneficiaries are empowered and lessons learned are applied both in the field and at the program level, thus increasing the effectiveness.

The emphasis in participatory M&E is placed on beneficiaries and stakeholders not as providers of information, but as active participants in the evaluation process. Supplementing more formal methods of inquiry, such as standard questionnaire or one-to-one interviews, with non-formal techniques can yield rich information than the use of only formal methods.

Collaborative Evaluation Approach

A collaborative approach is one form of participatory approach in which the evaluator works directly in partnership with a group of stakeholders (people who have a stake, i.e., vested interest, in how the evaluation comes out) to focus key evaluation questions, design the evaluation study, interpret the results, and apply findings. This is a process of shared decision making. The evaluator is “active-reactive-adaptive” in facilitating an evaluation process that addresses the concerns, interests, questions, and information needs of a group of stakeholders organised into some kind of evaluation task force. The evaluator helps the task force members to deal with the issues of utility, feasibility, propriety, and accuracy, but does not decide unilaterally how these standards of excellence will be met. While in a normal situation, the evaluator is completely responsible for the process and responds to the audience's requirements for information.

The process of collaborative evaluation involves:

- Discussion with clients, program staff, and audiences, i.e., everyone in and around the program, to gain their expectations and purpose for the evaluation;
- Based on these discussions, the evaluator places limits on the scope of the evaluation program;
- The evaluator begins to discover the purpose of the project, both stated and real, and the concerns that various audiences may have with the project and/or the evaluation;
- The evaluator then begins to conceptualise the issues and problems that the evaluation should address;
- Design the evaluation process. Given the data needs, the evaluator selects whatever approaches are most useful for generating the data;
- The evaluator now proceeds to carry out the data collection procedures that have been identified;
- Once the data have been collected and processed, the evaluator shifts to an information reporting mode. The evaluator also identifies the key issues for reporting; and
- At times, evaluators' are not very skilled at working with groups. They need patience, sensitivity, and good humour.

Steps in participatory evaluation

In general participatory evaluation consists of four basic phases: pre-planning and preparation; generating evaluation questions, data gathering and analysis and reflection and action. These steps are discussed in the following sections.

Pre-planning and preparation

This phase of the participatory evaluation is managed at the institutional level far from the day-to-day lives of end users. In order to establish stakeholders interest in conducting participatory evaluation mobilise broad-based support by soliciting end users input and collaboration. Since participatory evaluation strives for transparency, openly discuss the purpose, goals and objectives and the various supporting or competing agendas of evaluation.

Establish who wants to know what for what purpose? Review program document to gain an understanding of the context. Review available baseline data. Address logistical matters such as terms of reference, identifying participatory evaluation participators and stakeholders, and other administrative matters.

In order to make this step participatory:

- Outline a conceptual framework based on participatory evaluation principle;
- Define parameters for the participatory evaluation (i.e. what can and cannot be achieved);
- Assess constraints and resources or enabling and inhibiting factors;
- Identify the participatory evaluation facilitator, team members and stakeholders – use wider consultation; and
- Negotiate the purpose and objectives of participatory evaluation with key actors.

Generating evaluation questions

At this stage of the process:

- Discuss and decide with end users which data collection methods have high probability of yielding data that are useful and relevant to both outsiders and insiders.
- Assess the current research skills of the persons involved in the participatory evaluation and provide training as needed.
- Determine whether or not different methods will be needed for collecting various types of data. Consider a mix of data gathering techniques.
- Take into account prevailing socio-cultural and political climate. Specific issue to address are:
    - Sensitive to socio-cultural milieu;
    - Indigenous language issues; and
    - Gender issues and cultural diversity (minority groups)

- Negotiate evaluation questions with stakeholders. This may involve field visits and workshops.
- Negotiate data collection techniques and provide training as needed. At this stage the evaluator/evaluation team works shoulder-to-shoulder with key actors.

At this stage in order to improve participation:

- Facilitate participatory workshops or field visits to stakeholder workplace or residence.
- Collectively identify the focus of the evaluation.

Data gathering and analysis

At this stage of the process:

- Design appropriate venues for meeting with en-users and working with them in a participatory manner.
  - Workshops of cross-section of representative end-users, multilevel and multifaceted.;
  - Field visits for face-to-face contact; and
  - Small groups working as focus groups.
- There may be a need for through instruction or training for the evaluation team members.
- Triangulation and cross checking of information is vital to verify and validate the process and data.

In order to facilitate participation:

- Provide necessary training in data gathering methods;
- Gather data collectively; and
- Analyse data collectively.

Reflection and action

Empowerment is the critical aspect of this process. The best rule is to 'know that we do not know' the new situation as do the people who live in it. It is through our disempowerment that they are empowered.

The final phase of the participatory evaluation is characterised by the creation of solutions to end-users problems. The group should begin with the problem or evaluation questions that were originally defined and articulated by end users.

The goals of this activity are:

- To validate end-users experience by using it as the basis for future action plan rather than using outsider's experience/plan;
- To motivate end users to find solution and act on them rather than avoid them; and
- To promote a sense of self-determination and sustainability through feelings of empowerment.

In order to improve participation:

- Prioritise problems to be solved or questions to be answered;
- Co-ordinate resources for solving problems identified during the evaluation; and
- Take collective action.

Projects and programs that have a clearly identified group of end-users and beneficiaries lend themselves to experimentation with this methodology.

A wide range of methods and tools have been used in PM&E. These include maps, Venn diagrams, flow diagrams, diaries, photographs, videos, matrix scoring, network diagrams etc. Some of these tools are discussed elsewhere in this sourcebook. The duration of the evaluation will vary depending on its complexity and availability of stakeholders to participate in all aspects of the evaluation.

The entire process may involve several workshops with the stakeholders. A planning workshop, where stakeholders can define the parameters of the evaluation, a smaller workshop for data collection and possibly another workshop for the analysis of data and feed back.

The degree and level of participation will depend on a number of factors.

- Context of the project;
- Degree of willingness and commitment on the part of all stakeholders to participate in a participatory evaluation process;

- Availability of baseline data;
- Availability of time and resources to enable stakeholders to collect data; and
- Any external constraints that may impede stakeholder participation

If the evaluation process is to be meaningful, then at the very least, stakeholders should participate in defining the parameters of the evaluation, analysing the findings and proposing solutions. Their involvement in the collection and analysis of data may depend primarily on the availability of time and resources. Ideally the evaluation report should reflect the findings, concerns and recommendations of the stakeholders.

Characteristics of an evaluator/facilitator

Three evaluator styles have been identified in the literature. These are:

- The surveillance and compliance approach where the evaluator is independent and can be highly critical. Program personnel are viewed as potential or suspected outlaws. The evaluator is on a mission of law enforcement, i.e., emphasises justice.
- The second style is that of the aloof and value-free scientist who focuses single-mindedly on acquiring impeccable data. This style emphasises on truth. Program personnel are research subjects to be labelled and studied in accordance with the roles of science.
- The third style is when the evaluator works in consultative consensus building process to help policy makers and program personnel co-operatively and openly clarify their information to improve their effectiveness. All are treated as partners in the search for useful information, i.e., emphasises utility.

The evaluator needs the co-operation, good will, and interest of a variety of decision-makers and information users to conduct a high quality and useful evaluation.

The consultative style aims at four practical accomplishments. These are:

- Getting decision makers and information users to share responsibility for the evaluation;
- Getting decision makers and information users to care about the evaluation;
- Making sure that decision makers and information users understand the evaluation process and evaluation findings; and
- Increasing the personal commitment of decision-makers and information users to actual use evaluation processes and findings.

In participatory evaluation the evaluator plays a facilitating role.

Typically a social science researcher or development practitioner with considerable field experience, experience as educator of adults or as informal trainer; and reasonable grasp of qualitative methods such as PRA and group dynamic techniques is chosen as an evaluator. They must also have the capacity to listen, guide and facilitate discussions, helping the group to ask key questions, encourage trust, delegate tasks and responsibilities, plan action to help bring together the view points of various stakeholders; and create an environment of sharing and reflection.

The facilitator must act as a catalyst or stimulator managing the evaluation without being seen as directing it.

Group Dynamics

One of the greatest benefits of the participatory approach to evaluation is the group dynamics that the process generates. Several things that can be accomplished with a group are less likely to occur with individuals.

For example (Things that can be accomplished with a group):

- An environment of openness can be established to reduce suspicions and fears about what is going on in the evaluation. The key stakeholders who participate in the process know how decisions are made and who was involved in making them.
- Participants in the group process become sensitised to the multiple perspectives that exist around any program. They are exposed to divergent views, multiple responsibilities, and competing values. Their view is broadened. This increases the possibility of conducting an evaluation that is responsive to different needs, interests and values.
- New ideas often emerge out of the dynamics of group interaction.

- A sense of shared responsibility for the evaluation can be established. Commitments made in groups, in front of others, are typically more lasting and serious than promises made to an evaluator in private.
- It is difficult to suppress touchy questions or negative findings. Issues get raised and findings get publicised that otherwise might never see the light of day.
- The evaluator can assess the interpersonal relationships among the various stakeholders. This information can be very helpful in developing utilisation strategies.
- It is possible to generate some momentum that helps to reduce delays or roadblocks resulting from the attitudes or actions of one person.
- The group will often continue to function after the evaluation is completed. Participants can develop a shared commitment to follow through on utilisation of evaluating findings and recommendations. Stakeholders stay with the program after the evaluation is over.

Measurement and Assessment of PM&E Indicators

M&E involves asking a number of broad questions concerning project output, effect and impact. Essentially, we need to know what happened as a result of the project activities, when and to what extent. We need to understand the economic, political and social changes which have occurred and how these are perceived. For this purpose, indicators need to be identified and agreed upon to illustrate the results and changes we are looking for. The use of indicators is a prominent feature of most M&E systems.

Participatory projects are often intended to minimise top-down planning and encourage responsive, two-way styles. This necessitates the adaptation of criteria to measure the success and progress of these projects.

Indicators measuring underlying trends are central to most M&E processes. However, standardised indicators are problematic, because the quality of participation can only be assessed through a process that is itself participatory. The selection of indicators to measure and assess primary stakeholder participation is therefore still a relatively new field

Challenges for selecting the best indicators include:

- Balancing locally relevant factors with those that can be applied more widely.
- The selection process can be time-consuming; especially if many stakeholders are involved.
- They should capture the tangible and intangible changes.

Alternatives to traditional approaches have focused less on quantitative results and more on qualitative processes. PM&E therefore involves some tangible, physical or material outcomes, which will be visible; quantifiable; ultimately measurable; and of which the extent of change can be judged. However, it also involves qualitative processes. These have to be described and ultimately interpreted to understand the changes that occurred. In addition, participation as a process unfolds throughout and after the life of a project and therefore has a time, or sequential, dimension as well. PM&E is concerned with all three dimensions and appropriate systems need to be established to monitor all of them.

Quantitative indicators

These are most commonly used in project frameworks to measure the extent and magnitude of changes. Whereas the quantification could be sufficient in relation to outputs, the qualitative dimension of participation at the project purpose level should be made more explicit. This is especially valid when participation is an end in itself; and the project success depends on empowering participants to accept increasing degrees of responsibility and control.

Qualitative indicators

Qualitative PM&E indicators are more difficult to specify and use, partly because of the interpretative leeway associated with them. They explain the nature and quality of participation. This essentially involves descriptive statements about the process and outcome of participation, i.e. descriptions of attributes, traits or characteristics which are not in themselves quantifiable. The latter includes aspects such as decision-making and management capacities, ability to draw up micro-plans self-monitoring roles, group solidarity and sustainability. Such statements draw attention to aspects of participation which numbers alone cannot capture.

However, qualitative statements are rarely context-free and their appropriateness in a specific project should be carefully considered. Their appropriateness is often influenced by cultural norms, which reiterates the importance of primary stakeholders' participation in defining them. Some quantifiable information collected on standard monitoring forms or through surveys may act as proxies for qualitative performance.

Qualitative evaluation is based on the assumption that projects are dynamic and evolving and not simply following a pre-determined direction. It takes us beyond the number game and identifies key characteristics or phenomena, which could illustrate a process of participation and systematically describes and interprets activities and changes which occur in these. Whereas quantitative data can be measured and the extent of participation thus assessed, the more qualitative recordings and observations need to be interpreted in relation to the indicators used.

Sample of quantitative and qualitative PM & E indicators are presented in Box 16.2.

Box 16.2: Sample Quantitative and Qualitative Indicators

Quantitative Indicators PM&E Indicators

- Number of project level meeting and attendance levels;
- Percentage of different groups attending meetings, for example women and landless;
- Numbers of direct project beneficiaries;
- Project input take-up rates;
- Numbers of local leaders assuming positions of responsibility;
- Numbers of local people who acquire positions in formal organisations; and
- Numbers of local people who are involved in different stages of project.

Qualitative PM&E Indicators

- Improved and more effective service delivery;
- Organisational growth at community level;
- Growing solidarity and mutual support;
- Knowledge of financial status of project;
- Concern to be involved in decision-making at different stages;
- Increasing ability of project group to propose and undertake actions;
- Representation in other government or political bodies with relation to the project.;
- Emergence of people willing to take on leadership;
- Interaction and building of contacts with other groups and organisations; and
- People begin to have a say in and to influence local politics and policy formulation.

Note: It is also possible to convert some of these qualitative indicators into quantitative measures.

Time dimension indicators

The time dimension indicators is important for managing project implementation and monitoring; and directing stakeholders' attention to the phasing of participation. Participation activities are often specified in relation to a project calendar, thus serving as performance indicators for outputs. However, a set timetable could reduce the ability of the project to respond to specific local needs and problems. In contrast, time can also be referred to as a sequence. This is a central concept of milestone planning, which identifies the critical, logically related steps in implementation, while not necessarily placing time limits on each step.

The important things to remember are to:

- Work with the minimum number of indicators which could give a realistic understanding of the evolving process of participation;
- To determine the indicators on the basis of the characteristics and purpose of the project. There are no generic indicators for participation.; and
- Involve local people in determining how their increasing participation should best be monitored. Indicators do not necessarily have to be externally driven and supposedly objective.

Indicators need to be verifiable, expressed in practical terms and cost effective to use. The range of methods available should be taken into account, as well as the staff, budget and time implications. Extending the involvement of primary stakeholders through participatory self-evaluation systems is complementary to more conventional top-down systems. It facilitates the incorporation of local evaluative criteria and can also be a cost-effective way of monitoring the more qualitative aspects of participation.

Challenges for PM&E

Common mistakes encountered in PM&E include:

- Assuming that all stakeholders will be interested in taking part;
- Imposing inappropriate indicators and methods in an effort to standardise and save time;
- Being unclear about what information to collect; and how and by whom it will be used;
- Starting too big, too soon.; and
- Opening up the assessment process to a wider range of stakeholders may expose conflicts over what is most important; how it should be tracked; and whether goals are being met.

However, an appropriately designed and established PM&E system provides a framework for clarifying and negotiating differences between stakeholders and developing a consensus on what priorities are. This requires openness; a willingness to listen to different points of view; and recognition of the knowledge, role and contributions of different participants.

The major challenges for PM&E to flourish include:

- Established notions of rigorous data collection and analysis are challenged when people with different points of view are brought together. Conventional concepts of validity and reliability are questioned as methods are combined in new ways and experts increasingly interact with local people. More emphasis is placed on information that is "good for the task at hand" rather than being perfect.
- Experience suggests that it is preferable to start small and create opportunities for PM&E to be tested before the process is scaled up and introduced more widely.
- Training at all levels, from villagers to senior management.

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Evaluation as a research management tool

Introduction

Evaluation activities are an integral part of good management, and that research leaders will find reviews and evaluation of their programs a useful and constructive tool for management and planning. The systematic inclusion of reviews and evaluations into the planning, programming, and implementation process is likely to result in a more coherent solution of research priorities and approaches and in more realistic program design. It places the research leaders and managers in a stronger position when informing policy makers, so that the potential contribution of research to development is likely to be both understood and supported at the highest levels of government. Horton (1990) argues that impact assessments are most valuable as a management tool when conducted as an integral part of the research planning and implementation process.

Purpose of Research Evaluation

The basic economic rationale for R&D evaluation is to in improve the efficiency of allocation of research resources as well as to improve the standard and effectiveness of decision making. The economic theory suggests that to maximise social output, resources should be allocated where their contribution is greatest at the margin. At the same time one operational matter of interest to research managers is to seek feed back on what has been accomplished in order to help them direct the course of future work. The R&D evaluation tries to address both these issues in a systematic manner.

In defining evaluation as a management tool, one should assume that certain basic conditions exist. These include:

- There must be clearly defined targets and key indicators and they must be determined in advance;
- The principal purpose for carrying out an evaluation needs to be clearly stated; and
- The scope of the evaluation must be clearly understood.

When evaluating the impact of research, a differentiation must be made between research results and the contribution they make toward greater development objectives. Research creates only the potential for development, whether or not this is realised depends on many other factors.

Invariably, evaluations simultaneously address several of these aspects. Thus, a combination of methods is often chosen in conducting empirical evaluations. For any given measure, there might be several techniques, the use of which will depend on available data and personnel to conduct the analysis.

Currently there are two major reasons for supporting economic evaluation of research. These are:

- To obtain evidence that will support cases they make externally to maintain current levels of funding in the case of threatened cuts; and
- To help prioritise areas of research to identify low returns areas for cuts and to identify high return areas and new opportunities for increased funding.

The objective of research evaluation therefore is to increase the benefits from scarce research resources. This can happen in various ways, such as:

- By eliminating projects with low benefits, i.e., by culling unbeneficial research;
- By directing funds to most beneficial research efforts;
- By changing the emphasis or design of a research project;
- By facilitating information flow through the TDT systems and across disciplines; and
- By providing an appropriate focus and paradigms for research leader/managers majority of them usually have a scientific rather than an economic background. The general framework for research evaluation is provided by benefit-cost analysis which involves estimation of costs and benefits over time and discounting them to obtain valid comparisons of their present values.

Research Management and Research Administration

Allen (1976) made a useful distinction between research management and research administration. Usually among other things research management involves three sets of decisions. These decision sets are:

- The amount of resources to be allocated to research;

- The choice of research problems to be investigated with available resources; and
- The appropriate research strategy to be employed in the investigation of a given problem.

Research administration on the other hand involves the day to day decisions required to efficiently carry out the research task. The benefit - cost framework used in most R&D evaluation is suitable for dealing with management decisions only.

Groups Interested in R&D Evaluation

The finding of evaluative activities can be used for different purposes by different levels of management at different phases over time. As summarised in Table 17.1, several groups are interested in the outcome of R&D evaluation for different reasons. These groups include:

- Policy makers:
  - National;
  - Regional; and
  - International.
- Donors;
- Research managers and administrators;
- Research group leaders; and
- Researchers.

Table 17.1: Groups Interested in R&D Evaluation

Evaluation Activity	Policy Makers	Donors	Research Managers/ Program Leaders	Researchers
Review of entire research system	X	X	X	X
In-depth review of component		X[1]	X	X
Ex-ante evaluation of program/project		X[1]	X	X
On-going evaluation/monitoring research activities		X[1]	X	X
Ex-post evaluation of a research program/project		X[1]	X	X
Impact assessment	X	X	X	X

[1] Depends on their interest or the activity that they are funding.

Policy makers and donors

Policy makers and donors are interested in research evaluation in order to:

- Select priority research themes to establish a research plan;
- Justify past decisions;
- To improve the efficiency of the research system; and
- To trace the contribution of a program to development well after the project is completed.

They will use the evaluation information to allocate resources. They are interested in both qualitative and quantitative information and are very keen in looking at the people level impact of research initiatives.

The findings of a comprehensive, interdisciplinary review of the total system of a sector/country will be used to select priorities and draw an overall research plan. The findings from such reviews are used by governments to decide on overall research priorities, resource requirements as well as allocation within the context of the broader development goals. The comprehensive review is also of some interest to the research managers and program leaders.

Research managers, administrators and program leaders

This group is interested in research evaluation for various purposes depending on the timing of the evaluation. These purposes include:

- During the design stage of a specific program to establish the program.

- During the program implementation:
  - To verify that implementation is proceeding as planned;
  - To identify bottlenecks/problems; and
  - To guide/plan revision.
- When the program is completed:
  - To assess achievements;
  - To understand factors influencing outcomes; and
  - To contribute to better design and follow up.

Evaluation activities at the design stage include more detailed analysis of researchable problems and reviews of available necessary resources (in staff, budget, and infrastructure) for the purpose of selecting appropriate research topics and approaches.

During program implementation, more detailed information is needed. Usually users of such information are limited to the people involved in or responsible for implementation.

Individual researchers

Their interests are similar to these of the research managers and program leaders but at a different level. They are more interested in their own individual project. They are concerned with evaluation information for various reasons. This information includes:

- At design stages - screening and identification of an appropriate project;
- At implementation stages - (on going evaluation) to identify and overcome bottlenecks;
- At the end of the project - to document achievement and management problems; and
- Well after the completion of the research project - to assess the people level impact.

The findings at this stage will be used to estimate the actual contribution of the research results to development in order to understand which factors (within and outside research) influenced adoption and the ultimate impact, and to draw lessons for future planning as well as other development services and related policies. Users of this type of information are the top leaders of research and other development agencies and the policy makers.

Internal, External and Collaborative Evaluation

Evaluations can be carried out either by using evaluators from within the organisation or by bringing in expertise from outside the organisation/project or a combination of both. The actual procedure followed depends on the circumstance. Within the research services, it may be desirable to have some regular internal self assessment as part of the management process, and then continue this with periodical external evaluation. The advantages and disadvantages of these three procedures are summarised in the Table 17.2.

Internal evaluation is where people within the program collect the data themselves and performs the assessment. This type of evaluation is typically less expensive than evaluations conducted by external evaluators. External evaluation, however, tends to have more credibility and legitimacy than internal evaluation. For comprehensive program or institute evaluations, it may be desirable to bring in expertise from outside the organisation. The objectivity and specialist skills of the external evaluators can be an asset, especially for more complex or controversial research, for reviews of programs within institutes and their complementarity, and for suggesting major changes in the organisation's thrusts. The major disadvantage of external evaluation is the cost and a lack of familiarity with the organisation/project and/or country.

Table 17.2: Summary of Internal, External, and Collaborative Evaluation Procedures

Method	Advantages	Disadvantages
In-house Evaluators	• Familiarity with programs and staff operations • Consistency assumed with national value system • Less time required to schedule evaluations	• Objectively and candor may be questioned • Possibility of organisational role conflict • Difficulty of releasing staff from regular duties

	• Less expensive	
External Evaluators	• Greater objectivity • Free of organisational bias • Possible greater access to decision makers • Time exclusively devoted to the task • Familiar with recent advances in technology	• May be perceived as policemen and make staff anxious • Requires time for contract negotiations and orientation • More expensive
Collaborative Evaluators	• Advantages of both in-house and external evaluators, plus broader cultural and technical perspective	• Some candid discussion of sensitive issues may be constrained

Source: Modified by USAID, Design and Evaluation of AID-Assisted Projects 1980.

There are a good many possible combinations of internal and external evaluations that may be more desirable and more cost effective than purely internal or purely external evaluations. These are often termed as collaborative evaluations. For example, the internal group can collect data and arrange them. Then the external group inspects the data collected and collects additional data if needed. In terms of data, both “truth tests” (whether data are believable and accurate) and “utility tests” (whether data are useful) are important to decision makers, information users and other stakeholder.

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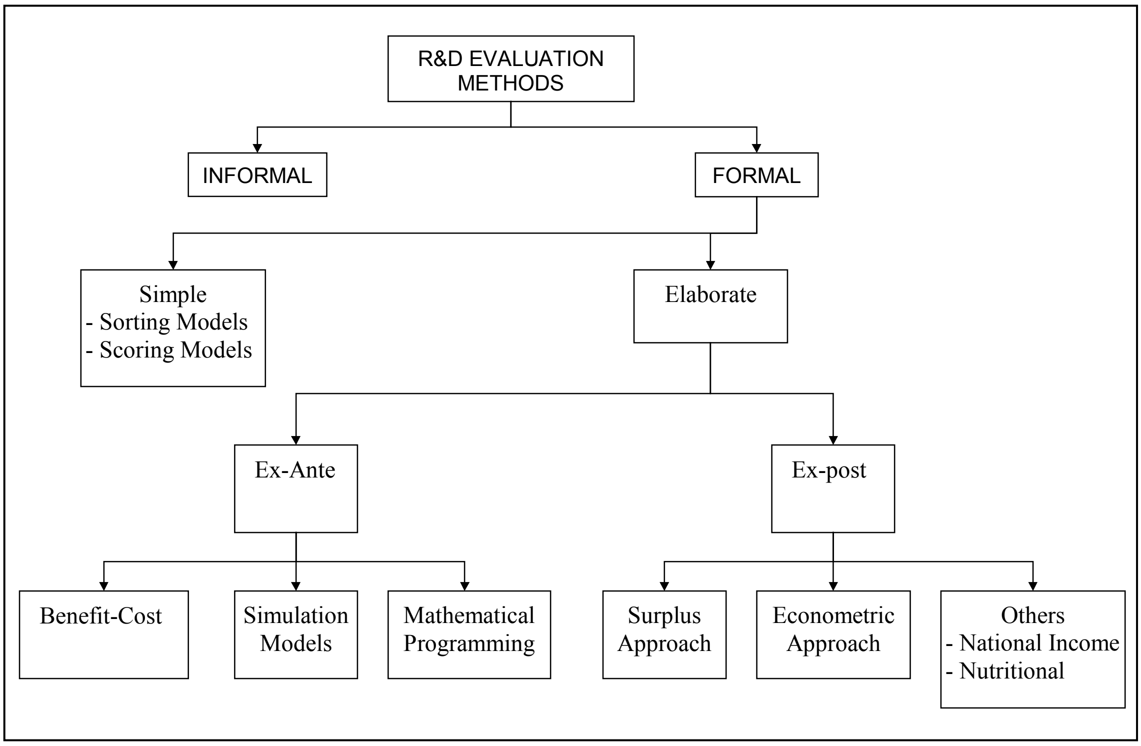
OVERVIEW OF R&D EVALUATION METHODS

Introduction

In this chapter an attempt is made to summarise the various methods and approaches used in R&D evaluation. The approaches used for R&D evaluation can be informal or formal. The entire range of methods available for R&D evaluation is summarised in Figure 18.1. It is also worth noting that some of these techniques are also used in impact assessment.

Figure 18.1: Summary of R&D Evaluation Methods



Source: Based on Norton & Davis (1981).

Informal Methods

This approach largely depends on the subjective judgement based on the local knowledge and concern for client's demand. Based on these subjective judgement of well-informed individuals resources are allocated.

Formal Methods - Simple

Sorting models

This involves compilation and presentation of information concerning selected characteristics of research projects. Very often a multidimensional tabulation of measurements or estimates for each project are used to facilitate decision-making.

Scoring models

This approach attempts to list subjective rating of projects by various criteria. Then the projects are ranked using some rudimentary weighing or using un-weighted total score.

The problems incurred in simple formal methods include:

- Vested interest of decision makers will lead to research bias;
- Time variant properties of the projects are not included; and
- Scales were not proportional to the financial measures of costs and benefits.

Formal Methods - Elaborate

Depending on the timing of the assessment, formal methods can be classified under two groups: the ex-post and ex-ante methods.

Ex-post evaluation techniques

The available techniques for ex-post evaluation can be broadly grouped under four categories.

Category One - Surplus Approach

Formal methods under this category are those using consumer and producer surplus directly and estimating an average rate of returns for research, i.e., the economic surplus approach. The methods under this category include cost - benefit, index number and cost-saving approach. This approach measures the increase in the value of output caused by research from a given level of conventional input. Return on investment is estimated by measuring the change in consumer and producer surplus from a shift to the right in the supply curve due to technological change. The details of the surplus are discussed elsewhere in this sourcebook.

The main advantage of economic surplus approach is that it allows the distribution of benefits between producers and consumers to be calculated.

Category Two - Econometric Approach

Methods included in this category are those estimating a marginal rate of return to research by treating research as a production function variable, i.e., the econometric approach. This approach uses production, profit and supply functions and their derivatives in estimating the rates of return. Production functions have been widely used for this purpose. This method treats research as a variable and allows a marginal rate of return on investment to be calculated. This includes lagged research expenditures as variable or inputs in a function. The production function approach is discussed in much more detail in chapter 24 of this sourcebook.

The major advantage of this approach is that it offers a more rigorous analysis (statistically) of the impact of research on output. It allows for the estimation of marginal as opposed to average rates of return. In addition, it is useful for separating the production effects of research from those of educational, conventional inputs, and other complementary services.

Major disadvantages include data problems and econometric problems.

Category Three - Others

This category includes estimating the impact of technology on national income, and measuring the nutritional impact of agricultural research, i.e., increased output on nutritional status of population.

Category Four - Inputs - Saved Approach

The fourth category includes the input-saved approach.

Ex-ante evaluation techniques

Once again these methods are classified under four main groups. These are:

- Those using scoring models to rank research activities;
- Those employing benefit cost analysis to establish rates of returns to research;
- Those using simulation models; and
- Those using mathematical programming to select an optimal mix of research activities.

The attributes of these various techniques are summarised in Table 18.1.

Since we will be discussing some of these methods in detail in subsequent chapters, here we will deal with three of these techniques, namely the simulation approach, the input-saved approach, and mathematical programming.

Table 18.1: Comparison of Ex-Ante and Ex-Post R&D Evaluation Methods

	Ex-Post Techniques		**Ex-Ante Techniques**			
Characteristic	CS	E	Sc	B-C	Si	MP
1. Requires explicit elicitation of goals	no	no	yes	no	no	yes
2. Can determine distributional effects on consumers and producers at various income levels	yes	no	no	yes	yes	no
3. Can consider secondary impacts of research on employment, environment, nutrition	sometimes	no	sometimes	sometimes	yes	no
4. Can consider tradeoffs among goals	sometimes	no	yes	sometimes	yes	yes
5. Can consider economic policy and trade effects	yes	yes	yes	yes	yes	yes
6. Relative cost in analyst's time	medium	high	medium	medium	high	high
7. Relative cost in scientist's time	low	low	medium	medium	high	medium
8. Relative cost in administrator's time	low	low	medium	medium	medium	medium
9. Relative data requirement	medium	high	variable	variable	variable	variable
10. Relative ease of comprehension by decision makers	medium	low	high	medium	low	low
11. Can evaluate benefits to "aggregate" research	yes	yes	no	yes	yes	no
12. Can evaluate benefits to commodity research	yes	yes	yes	yes	yes	yes
13. Can evaluate benefits to research projects or program	yes	no	yes	yes	yes	yes
14. Can evaluate benefits to non-production - or non commodity - oriented research	difficult	no	yes	difficult	sometimes	yes
15. Can provide ranking of research projects based on multiple goals	no	no	yes	no	no	yes
16. Can handle uncertainty	yes	difficult	yes	yes	yes	yes
17. Can consider the lags involved in research and adoption	yes	yes	yes	yes	yes	yes
18. Can quantify public sector/private sector interaction	no	sometimes	yes	difficult	sometimes	difficult
19. Can quantify research-extension interaction	no	sometimes	no	no	sometimes	no
20. Can quantify spill-over effects	yes	yes	no	yes	yes	no
21. Usually estimates marginal rate of return	no	yes	no	no	sometimes	no
22. Usually estimates average rate of return	yes	no	no	yes	sometimes	no
23. Calculates return while statistically holding non-research inputs constant	no	yes	no	no	sometimes	no
24. Can help identify or quantify factors most affecting progress in given research line	no	no	yes	yes	yes	no
25. Can be used to evaluate basic research	no	sometimes	sometimes	difficult	sometimes	no

Note: CS = Consumer Surplus; E = Econometrics; Sc = Scoring; B-C = Benefit - Cost (also known as the expected consumer surplus method); SI = Simulation; MP = Mathematical Programming

Source: Based on Norton and Davis (1981)

Simulation Approach

Simulation models are widely used for research evaluation in the private sector than for public agricultural research evaluation. The reasons are:

- Industry research process is better understood and/or more tightly planned and controlled;
- Private research and development are likely to be:
  - Less uncertain about its payoff;
  - More applied and less basic than public research.

Steps in the simulation approach

These steps include:

- Establish overall goals;

- Identify changes in product supply, input demand and farm consumption necessary to achieve those goals;
- Identify research problems and alternative technologies to solve them;
- Identify the time, costs and probabilities involved in research and farm adoption of the alternative technologies;
- Estimation of effects of farm consumption, product demand and input supply flows; and
- Specification of technology to be developed and scientists' working objectives are established.

Disadvantages of the simulation approach

The major disadvantage of the simulation approach is that it requires an extensive amount of data and estimation of numerous mathematical relationships. The construction of an appropriate simulation model requires much time and information.

Advantages of the Simulation Approach

The major advantages of the simulation approach are that the models are flexible and can be used to estimate optimal levels of research at a national, commodity, or program level, as well as the effects of research on prices, income, employment, or other parameters.

The Input-Saved Approach (Average Returns)

Schultz (1990) did the pioneering work in the input-saved approach. In this approach the resource savings are estimated by determining how much of the various resources would have been used to produce the output of a base period using the techniques of production of an earlier period. A comparison of this with the resources actually used provides an estimate of the resources saved. The value of the resources saved constitutes the benefits from research. The costs of producing theses benefits are then estimated by calculating the cost of all research and extension in the country - both public and private.

A benefit - cost ratio can be calculated or the data can be used to estimate the social rate of return. Resource savings could be estimated either from experimental data or survey of farms. When combined with the extent of use of the innovation, an estimate of the total resources saved could be made. This approach is especially useful for evaluating innovations that are more directly resource-saving than output-increasing.

Mathematical Programming

This method provides a more powerful and sophisticated priority setting technique in that it relies on a mathematical optimisation of a multiple goal objective function, subject to resource constraints (available funding and human resources) to select a portfolio f research projects.

Advantages of the Mathematical Programming Method

The mathematical programming method selects an "optimal" portfolio taking into account the various evaluation criteria and constraints imposed in the programming problem rather than simply ranking research areas.

Disadvantages of the Mathematical Programming Method

The mathematical programming method is not particularly useful for evaluating too diverse a set of R&D projects. In addition, if either the criteria for project assessment or the constraints faced in executing the projects are not well defined, then nonsensical solutions can result.

Other Methods

In addition to the above methods, there are a few other approaches that are being used to assess the quality of research. This includes peer review and bibliometric methods. These two techniques are discussed in the following sections.

Peer Review

If the research quality is the primary concern of the evaluation, then peer review or expert review of some form is the most useful tool to use. The Organisation for Economic Co-operation and Development (OECD,) has identified the following types of peer review:

(a) Direct peer review is defined as a review by scientific peers, which is confined to determining the scientific merit of an activity. Committee peer reviews are common. Committee members may reach decisions individually, through a group consensus, or in a phased combination of both.
   - Criticism:
     - → Multi-disciplinary research is difficult to assess.
     - → Where resources are severely constrained, the peers may be in competition with those being reviewed.

(b) Modified peer review is similar, but the criteria are broadened from scientific merit to cover the socio-economic aspects of strategic and applied research. This requires integrating non-scientists into the direct peer review process;
   - Most frequently used approach is to include users of research on committees and panels;
   - A two-stage process is often used: one that looks at 'good science' and the second which looks at 'relevance';
   - Another approach is to supplement the conventional direct peer review with interviews and/or questionnaires to add more and different information to the evaluation;
   - Problem:
     - → Obtaining a balanced review.

(c) Indirect peer review is based on information from peer reviews conducted for other purposes;
   - Commonly used indirect peer reviews are: Scientific awards, Bibliometric analysis, articles appearing in scientific journals, number of citations in journal articles, etc.
   - Problems:
     - → Data may not exist in developing countries, time and expense.
     - → Bias toward English journals.
     - → Poor coverage in the data base of certain fields, especially in applied and adaptive research.

Problems with peer review:
   - Successful peer review depends on the evaluator's objectivity, true scientific expertise and a common objective of improving research;
     - → Depending on the personalities, skills, conflicts and competitiveness within the organisation, peer review may be negatively applied. One solution to this problem is the inclusion of foreign experts where competitiveness or lack of scientific expertise exists.
   - The problem of scientific objectivity also becomes greater when the research is multi-disciplinary or aims to achieve social and economic objectives;
   - The methods that rely heavily on publications and citations indices are also considered less relevant to developing countries conducting applied or adaptive research; and
   - More significant is the growing use of methods such as questionnaires and structured interviews to gather information. These can reach large numbers of practising scientists, development workers, extension services, etc., thus bringing more information to the traditional peer review process.

Bibliometric method

Bibliometric indicators (and its variants) are essentially tools for assessing the quality of science associated with R&D activities, and are not of much use for assessing the associated economic and social benefits. The use of bibliometric indicators is based on the assumption that progress in science comes from the exchange of research findings, and that the published scientific literature produced by a scientist or from a particular R&D project is a good indicator of the projects of scientists' progress. The simplest bibliometric indicator involves a count of publications. However, over the last decades a number of additional indicators have developed, including citation indexing analysis, co-citation analysis, co-word analysis and co-classification analysis.

Most bibliometric techniques are of little use for assessing social and economic benefits, but, one particular variant has attempted to gauge the economic consequences of R&D - the patent analysis. The principal behind the patent analysis is that the technological performance of an R&D activity can be assessed by counting the number of patented products, processes or systems that come out of the activity.

Problems with bibliometrics

The major problems in using the bibliometric technique are:

- It is dangerous to assume that patents are the sole output of research;
- Patents do not arise uniquely from a particular R&D project, nor is it an indication of failure if the project does not lead to a patentable result;
- Firms have variable properties to patent and these may change over time; and
- From the point of view of assessing the social and economic impacts of R&D, patent analysis provides no indication of whether the patented item is in use, who the users are, or how large the user group may be.

The bibliometric method can be used as a partial indicator, when combined with other methods.

Selection of Methods for Evaluation

The method chosen depends on the purpose. If performance is the primary concern and the purpose, i.e., to improve institute or program management, resources and processes must be monitored and evaluated in what is often called a "performance audit." If research quality is the primary concern, then peer review or expert review in some form will be the predominant method to be used. If relevancy is the issue, then the primary method is a comprehensive evaluation based on technical and socio-economic analyses using experts from various disciplines. If impact is the concern, then depending on the particular aspect addressed, one could use a combination of methods.

The informal method is based on the subjective judgements. The formal method on the other hand can be simple or elaborate. The elaborate method uses some sort of a model or a quantitative technique. In using these methods, it is important to keep in mind:

- The quantitative models cannot substitute the creativity and judgement of informed participants;
- Formulas and models give an impression of pseudo-objectivity;
- Certain important elements are inevitably subjective; and
- At times some relatively simple guidelines could be provided as an aid for decision making.

KEY REFERENCE

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MANAGEMENT INFORMATION SYSTEMS

Introduction

Over the years it has been recognised that traditional reporting and evaluation practices are not adapted to information needs of an efficient management of research and development activities. Data and information are required for a number of purposes. *Ad hoc* data collection has proved to be expensive. To be cost-effective the required information to facilitate planning, implementation and evaluation of R&D activities should be collected as an on-going process. Thus, managers and decision-makers are increasingly relying on internal management information system (MIS) to obtain the relevant information for effective and efficient decision making.

An MIS system is like an umbrella system with several interrelated complimentary sub-systems serving a large number of functions – both administrative and managerial. The need for and the characteristics of a modern MIS system for R&D management are outlined in this chapter. Some of the key considerations in designing such an MIS system are discussed in the next chapter.

Definition

A management information system (MIS) is an ongoing data collection and analysis system, usually computerised, that provides managers with timely access to information on research inputs, activities and outcomes for various purpose:

Information is needed to set research priorities, to plan research programs, to monitor progress and to evaluate outcomes. These management tasks require access to the continuous flow of relevant, good quality information in a timely fashion from the different parts of the research organisation or system - from research programs, personnel and administration, finance and support services. If this information system is systematically linked, integrated and targeted to managers' decision-making needs, it is called MIS. It links and integrates diverse information from various parts of the organisation and targets it towards managers. There are basically two levels of MIS:

- Those designed for routine administrative tasks.
- Those that may be used for research management.

Management Information Matrix

The data basis designed for routine administration generally focuses on inputs such as personnel, payroll, accounts and supplies. They are essential for an overall MIS strategy because they contain the basic data required for management decision-making. However, research managers also need specialised information on the content of research programs, progress, results and collaborative work with other scientists or organisations. The linking of information on these research inputs, activities and outputs is the principal focus of MIS. The various components of a MIS system and their relevance are summarised in Table 19.1.

The horizontal axis shows the types of decisions that a research manager needs to make. When trying to reduce overhead costs, a manager deals with planning and programming. When current or completed activities are being assessed, the manager is involved in monitoring and evaluation. The vertical axis shows the data elements or information components that make up a MIS: The research programs and the resources required to do the research (staff, finance and equipment).

The first step in defining a MIS should involve determining managers' information needs and the adequacy of the information systems currently in place. Based on this the scope and content of the database could be determined. The decision about the computer hardware and software is limited to the content of the database – issues related to information technology are less critical than database content and use, i.e. computers are not a prerequisite for an effective information system.

Table 19.1: The Management Information Matrix

Information	**Decisions**	
	Planning and programming	**Monitoring and evaluation**
Projects and experiments	Strategy Tactics	Output Impact

Human resources	Recruitment Career Training	Performance
Finance	Budgeting	Accounting Auditing
Equipment Facilities Supplies	Utilization Procurement	Stock control

Need for MIS

Information is required at all levels of the research system. For management purposes, it is needed by project managers; program or department heads; institute or centre directors and system managers who may manage several institutes or perhaps the entire national research system. At lower level the information should be technical and more detailed. At higher levels, the information should be aggregated to allow broader analysis. At every level management must know who is employed, what funds are available and what research is being done. The information generated is usually used for planning, monitoring and evaluation. An integrated MIS should be able to answer the following questions:

- Amount of resources employed in any research program, for example what percentage of staff time and budget is used for research on maize, wheat or legumes.
- What activities are undertaken by any research program.
- The total number of professional staff, their disciplines, skill requirements, training needs, retirement date/age.
- If the MIS contain research goals and milestones comparisons can be made between the targets and actual performance of projects or programs.

It is important to remember:

- MIS systems can only provide information on what is happening. They cannot make decisions, i.e. a MIS system is not a substitute for decision-making.
- A MIS is more effective when it is computerised. This is especially true for large organisations or programs. Computerisation eases data analysis and presentation, but it can also create problems. People may become so captivated with computer technology that the goal of providing high quality information is lost amid the technological challenges and possibilities. Inflexible computer systems and software can result in the structure and design of the MIS being dictated by the technology instead of by what the manager requires. Computerised software may have problems. Using standardised computers and off the shelf software can reduce these problems.
- The value of the information derived from a MIS is dependant on the accuracy and efficiency of the procedures of collecting and inputting the data. These need as much managerial attention as the data processing and reporting.

Characteristics of MIS Strategy

Most institutions and programs have some sort of information collection system, however rudimentary they may be. Key characteristics of an effective MIS strategy include:

- **Evolutionary approaches.** Building on existing systems. A gradual approach is better than ambitious schemes that represent a radical break with the past.
- **Flexibility and relevance.** Focus of the system must be relevance, quality and timeliness. The system should be flexible enough to provide different kinds of reports, depending on their needs.
- **Computerisation.** An integrated MIS is easier when it is computerised.
- **Output orientation.** The MIS should be able to produce a variety of printed outputs for managers, not just the routine print notes. Furthermore, it should be able to respond to *ad hoc* requests for specific information.
- **Location.** The best location for a MIS unit may be in the office of the director in a planning and evaluation unit.

Computer specialists and statisticians often become more overly concerned with the technical issues of database management. They may then fail to produce the information managers when they need it.

If a separate MIS unit is established, it is important to maintain strong connections with the personnel responsible for research planning, monitoring and evaluation; and to avoid the danger of data collection becoming a routine administrative task.

If a decentralised approach is followed, implementation of MIS can be top-down, bottom-up or a mix of the two.

Until the arrival and wide availability of personal computers, MIS tended to be top-down, based on computer facilities at central locations. In some instances, there is a perception that lower level managers in the research system do not need or cannot use this information. Their role is then reduced to being providers of data. This results in:

- MIS is seen as an instrument of control imposed from the top for the benefit of higher level decision-makers.
- No incentive exists for the institute to collect the high quality information required and the MIS may loose its value.

Bottom-up approach – feasible, can be designed so that all individual institutes and stations/programs can have their own information systems, which provide information for management at the system level. This will benefit all participants; and it is more likely that institutes will co-operate and provide high-quality information. One possible problem may be the lack of consistency in data, formats and definitions among participating units.

Integrated application – If the MIS is decentralised, then the databases from different parts of the organisation need to be linked into one integrated information system. This could be a difficult task to achieve. In an integrated system data can be transferred between information systems, thereby avoiding expensive duplication in data collection. An integrated system can be costly at the beginning. It requires time for discussions, meetings and negotiations, as well as good communications. A great deal of negotiation is required with a lot of compromises to accommodate the needs of the various stakeholders.

Paperwork reduction – One recurring concern with new information systems is that researchers will be overloaded with forms and paperwork. In order to avoid this and to avoid unnecessary data collection, the system must be designed very carefully with a lot of attention to compatibility, coherence and collaboration.

There is not a single approach to develop a MIS system. There is considerable variation in the approaches used to create MIS, as well as their content and objectives. The traditional reporting and evaluation practices are not adapted to the information needs of an efficient management of R&D activities. The various aspects that need to be considered in setting up an M&E system are discussed in the next chapter.

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DESIGNING MONITORING AND EVALUATION SYSTEM

Introduction

Monitoring and evaluation (M&E) is a part of the process of project management. The existence of M&E system is essential for conducting any evaluation including an impact assessment. The process of monitoring and evaluation is the primary means of collecting and analysing information, and thus is intrinsic to good management. In order for M&E to be used in a more positive manner, management and staff must have a common understanding of the importance of the process involved the contribution of M&E in achieving the objectives of the research system. One principle cause of the failure of many M&E efforts has been the misunderstanding at the design stage of the purpose of such effort. Establishing and managing an M&E system involves both financial and human costs. The M&E function differs from project to project depending on the type of project and its components. Therefore, as discussed in previous chapters the terms M&E can be defined in many different ways depending on the purpose and needs of management. In this chapter, some of the aspects that need to be considered in setting up an M&E system are discussed.

Monitoring and Evaluation

M&E is defined as an integrated process of observation, information gathering, supervision, and assessment (Horton, *et al.,* 1993). M&E systems are set up to collect and analyse information that is useful to the managers of agriculture, research organisations at all levels. Information provided by the M&E system will be useful only if the following conditions apply;

- The effect of the research program and the target population is clearly defined in quantifiable terms;
- The way through which program/project inputs are transformed to outputs that are themselves related to the purpose of the program is clearly defined and understood, i.e., the production function is known with certainty; and
- The various degrees of attaining the program/ project objectives should be well defined and understood so that M&E system is designed to collect information on the effect of the program activities on the targeted beneficiaries.

To be cost effective, managers should decide on the minimum amount of information to collect on the basis of (a) the type of decision that this information will be used to make, and (b) the relevant importance of this information in the decision making process. Monitoring deals mostly with planning and control. Control includes gathering information on actual progress and performance, assessing deviations from targets, analysing possible causes of deviation, and taking remedial action.

In the past, M&E was treated as an integrated activity. However, Casley and Kumar (1987) argue that monitoring and evaluation is separated by their objectives, reference periods, requirements of comparative analysis and users. Therefore, monitoring and evaluation should be considered independently of each other, but there are common features which highlight the relationship between them. In many cases, the same data collection and analysis system will be used for both the indicators for monitoring, and may be included in the range of information required for valuation. The monitoring of a project may in itself reveal such significant departures from expectations that it calls for an interim, internal evaluation.

Monitoring must be integrated within the project management structure, but evaluation is a broad concept, and not necessarily an integral component of research management. Evaluation covers periodic reviews, as well more formally designated processes at fixed points in time, such as mid-term evaluations, terminal evaluations, and ex-post evaluations. Evaluation draws on the data base created during the monitoring process, supplementing this information as necessary with data on project impact, and reviewing the combined information over an extended period to judge achievement. Internal evaluations are a valid part of project management, but formal impact evaluation which measures the change that has come about and the proportion of this change attributable to the project requiring additional information is not a part of management. Monitoring, diagnostic studies, and eternal evaluation (including mid term evaluation) together form on-going evaluation. Certain on-going activities undertaken for monitoring purposes feed into the evaluation process. Given the fact that the impact of a project can be assessed only at its full development, i.e., some years after the activities completion, and given the limited budget and time frame, research managers are often more concerned with the direct product of research than about the benefits and impacts to be derived in the future, i.e., the research managers focus more on effectiveness analysis than people level impact.

Therefore, some evaluation responsibilities for research (other than ex-ante ongoing evaluations, and effectiveness analysis) maybe located within a central unit at the national level. In this case, project management functions and central evaluations functions must collaborate very closely in order to use the resources efficiently thus, monitoring must be seen as integrated with management, i.e., is an essential part of good management practice, and that evaluation is linked to monitoring, but distinct from it. This may be true for development projects, but for agricultural research projects, except *ex-post* impact assessment, all other forms of evaluation should be part of the management practice. The full potential of the monitoring function can be realised only when it is seen as an integral part of the management process. Conversely, evaluation as a management tool cannot succeed unless project managers accept its importance and usefulness. The various aspects of research evaluation are discussed elsewhere in this training manual. Therefore, this chapter deals with the monitoring aspect only.

M&E and Project Management

The two major uses of M&E are accountability and decision making. Accountability refers to, among other things, the responsibility of an individual or organisation to account for the proper use of resources. This aspect of M&E deals with the routine and assessing of impact. M&E is also used to help with decision making during planning, implementation, and periodic reviews of research activities.

M&E plays various roles during the project cycle. The term "project" includes both research projects as well as development oriented projects. The various roles of M&E during planning, implementation and review are::

- **At planning:**
  - Provide lessons from previous experiences;
  - Ex-ante assessment of proposed technical options, including its relevance; and
  - Evaluate research proposals to determine the optimal portfolio.
- **At implementation:**
  - Check input use against budget;
  - Check activities against the plan;
  - Check the program against milestones; and
  - Document input use, activities, and progress for future evaluation.
- **At review:**
  - Review the whole cycle, context, needs, goals, strategies, plans, implementation procedures, resource use, activities, progress, outputs and impacts to determine whether or not to continue the research as planned or to redesign the activities.

Monitoring and Type of Information

The monitoring function is carried out by using data within a management information system. Such a system includes the basic physical and financial records, the details of inputs and services provided to beneficiaries, and the data obtained from surveys and other recording mechanisms designed specifically to service the monitoring function. The primary role of monitoring is to assist management in establishing and maintaining the required information system, and to use it timely. Monitoring, therefore, encompasses the collection of recorded data and the collection of supplementary data for analysis, the interpretation required to make decisions concerning the functioning of a project.

Monitoring in general cover three types of information. These are:

- Physical and financial information;
- Beneficiary contact information, i.e., deals with the use of structures and services by the target population, and the initial consequences of that use; and
- Project diagnostic studies, i.e., this deal with unexpected reaction by the target population as well as information on social, economic, and environmental consequence.

Monitoring provides a measure of the interaction between the project activities and the reaction of the target population if it is to meet the needs of management. Monitoring is a tool for managers to use in judging and influencing the progress of implementation. The diagnostic studies may well indicate flaws that may question the project strategy or implementation tactics or both, but such studies supplement, not substitute for, the provision of information geared to the current implementation of the project.

Activities of the Monitoring Unit

Casley and Kumar (1987) outline the specific activities a monitoring unit should do in order to assist the operation of a management information system (MIS). These activities are as follows:

- Identification of targets for project implementation, and the indicators to assess the progress and the direction of these targets. Management involvement is essential;
- Collate, summarise, and disseminate the information coming from the various agencies and personnel that are implementing the project. In addition the administrative files and records on project implementation should be analysed;
- The project records and reports should be supplemented with the collection and analysis of data from the intended users of the project services and inputs;
- Analyse all available information with the aim of identifying problems being encountered in the implementation of the project. Diagnostic studies should then be conducted to shed more light on the nature, source, and extent of the problems;
- The various data series collected should be stored in a form that can be retrieved and used for other purposes, such as the evaluation of the project; and

From the various analyses, reports should be prepared, and the set of feasible alternative courses of action should be presented to management.

Beneficiary Contact Monitoring

As a project is implemented, the perceptions of its intended beneficiaries lead either to a growing demand for its services or its increasing irrelevance. Beneficiary Contact Monitoring (BCM) is the key to successful overall project monitoring. Three techniques can be used to track beneficiaries' attitudes and behaviour. These techniques are:

- Maintain records for each participant, and analyse these periodically to monitor the penetration of the services and the establishment of the clientele;
- Establish a regular schedule of surveys which utilise formal sampling methods; and
- Informal interviews which are quick and inexpensive.

BCM requires the identification of beneficiaries. The size of the sample used depends on the variation within a population of the viable being studied/tested; as well as the desired level of confidence that the estimate is within a given margin of the value for the population.

Designing and Setting Up a Monitoring Unit

In this section, monitoring is treated as an integral part of project management. The main issue is to design information systems, of which monitoring is a part, in a way that ensures that the project managers are involved, so that the contents and the range of monitoring meet the requirements of project managers. In the case of agricultural research project managers, this refers to the scientists who are responsible for planning, implementation, and control of the research programs and projects.

(M&E can be conducted at various levels of aggregation. It is applicable at the organisational level, as well as for specific programs and projects. The way in which an institution uses information in management decisions essentially determines the structure of its M&E system. The latter therefore differs between various organisations, programs and projects. This section describes the steps and procedures that could be followed to set up an M&E system for a specific program or project. This implies that the relevant stakeholders have reached consensus that the specific activity should be assessed. The analytical steps followed in the evaluation at this level are the same as that followed for an organisation. However, it takes place at a different level of abstraction and therefore allows us to discuss the various steps in more detail.

Choosing the type of evaluation system

Various kinds of M&E systems are available. The type of system chosen in a specific case mainly depends on the following factors:

- **What should be measured.** The evaluation should be based on the project design. Agreement is needed among various stakeholders about the crucial project issues that should be measured.

- **For whom it should be measured.** The users of the evaluation results should be identified and the results should correspond to their perceptions.
- **For what purpose it should be measured.** This determines the sensitivity of the measures and the degree of accuracy needed.
- **How it should be measured.** Consensus is needed between the evaluator and program/project managers on whether a proposed measure truly indicates a change in the desired direction.
- **How the data should be collected.** The design of the evaluation system should be determined and the desired level of accuracy in the information agreed upon.
- **When and in which format the information is needed.** It should be available when needed in a usable format and should be physically and mentally accessible.
- **Who collects, analyses and presents the information.** This needs to be known to adapt the M&E system to the management realities of a program/project. The time needed to analyse and present the information should not be under-estimated.

Defining the program elements to be measured

Stakeholders need to agree on the crucial issues of a program/project that should be measured. The following information is needed for this purpose:

- **Goal specification.** An evaluator needs to know what effects the program or project is supposed to have. However, goals are often vague and inflated and the people associated with the same activity might have different perceptions of these goals. The evaluator should assure that agreement is reached about project goals, which have to be expressed in measurable terms. Both expected and unexpected effects should be considered. A program/project might be altered during its implementation and it needs to be established whether the goals and measurements identified at the beginning are still relevant.

- **Program specification.** Agricultural programs are complex and projects with different activities and outcomes may exist under the same program. The program logic needs to be explicitly specified and agreed upon in terms of what the program elements are and how they relate to each other. This is essential to determine what outcomes can be attributed to the activity and to reflect on which components were successful or not successful.

There are many variables in agricultural programs that could be interesting to study. However, limited resources often necessitate choices among variables. The choices usually focus on the minimum of information needed to make the system worthwhile the best use of the available resources and the use of the information. In order to choose the variable to be monitored and evaluated it is necessary to know:

- The importance of the variable for the success of the project;
- The likelihood that management can influence a deviation of the real from the expected variable. Some variables are not under the control of management. Higher priority is given to critical variables that can be changed by management decisions than to critical variables that cannot be influenced;
- The degree of uncertainty of the information. For M&E purposes, higher priority is given to variables for which the true value is more likely to differ from the expected one; or for variables on which little secondary information is available; and
- The cost of collecting the information. Some information can be collected at a low cost, whereas other information requires complicated designs and data collection procedures. A trade-off is needed between the importance of the information and the costs of collecting it.

Monitoring and evaluation designs

An M&E system is supposed to provide information on the magnitude of changes that can be observed as a result of the program/project activities. This requires an appropriate evaluation design, which could be defined as *"an organisation of measures in ways to permit demonstration of achievement or non-achievement of the intended effects of the program"*. The choice of design partly determines the level of confidence that can be placed in the evaluation results. Potential threats to the validity of the results include:

- **Internal validity.** The design should yield unbiased estimates of the effects of the activity and should rule out competing explanations for these effects;
- **External validity.** M&E systems collect information on "representative" individuals to infer the effects of the program on all the individuals to whom the policy is being applied. Modern sampling techniques are used to counter the threats to external validity;

- **Construct validity**. The selected indicators should truly demonstrate what they were intended to;
- **Measurement reliability.** Data collection and analysis should be accurate; and
- **Policy validity.** This depends on the sensitivity of decision-makers to variations in the measurements.

There are two ways of designing monitoring information systems (Casley & Kumar, 1987); the blue print approach:

- **The blueprint approach.** Detailed organisational and work plans are formulated before implementation of program/project. These include objectives, data requirements studies to be undertaken, organisational placements, and staff and budgetary requirements. These plans dictate the design of the monitoring information system and are closely adhered to. This approach limits the flexibility of managers and monitoring staff to react to unforeseen and unexpected information needs. Since the approach is not participatory in nature, project staff is rarely involved in the design of the monitoring system. The approach is mainly justified when project staff and management have limited initiative and skill in monitoring. It is also preferred for straightforward activities, such as those that deal with the physical delivery of services such as infrastructure development. Implementation problems are essentially technical and mapped out in advance. Some on-station research programs/projects are also in this category when factors such as weather conditions and pests and diseases are controlled. The data needed to monitor these activities are straightforward in nature and therefore lend themselves to the blueprint approach.

- **The process approach.** The planning team outlines objectives, organisational arrangements and staff requirements. However, the project management is allowed to decide on the specific work plans and to design the monitoring information system on the basis of their needs. This renders the system an effective management tool. The approach is suitable when project managers and staff are highly qualified and experienced; and are also skilled and innovative at monitoring. It could be difficult to obtain this calibre of staff in many developing countries where relatively fewer people may be experienced in monitoring activities.

Evaluation designs differ in terms of their costs and their ability to distinguish the actual effects of the program/project from the possible changes that may not be related to these activities. Table compares the characteristics of six major evaluation designs, including case studies with one measurement and no control group, case studies with two measurements and no control group time series designs case studies with one measurement and control group; quasi-experimental designs; and experimental designs.

The choice of an evaluation design depends on various factors, such as the objectives of the evaluation, the intended uses of the results, the type of evaluation chosen, and the time, resources and skills available. In practice, an evaluator not always has the choice among the alternative designs shown in Table 20.1. Field conditions often impose limits on the kinds of studies that can be successfully completed. The evaluation design will depend on the ability to exclude alternative, plausible explanations for the observed change by circumstantial evidence. The formative evaluation of a relatively new project often relies on simpler designs and circumstantial evidence to refine the project understanding. Only once the project mechanisms are well understood can more powerful evaluation designs be optimally used.

The major dilemma in designing monitoring information systems is posed by the shortage of qualified and experienced staff to manage and monitor program/projects; and the need to render the system an effective management tool. One solution has been to incorporate both blueprint and process approaches within the system. The general design of the M&E system is based on the blueprint approach while the design of specific program/project activities during the implementation phase is left to project

Table 20.1: Data Collection Designs and their Characteristics

Characteristics / Evaluation Design	Cost	Reliability	Technical Expertise	Types Of Evaluation Primarily Adoptive To The Design	Ability To Measure What Is Happening	Ability To Exclude Rival Hypothesis
Case study: one: measurement (Actual vs. Planned)	Low	Very low	Low	Reporting	Very low	Non-existent
Case study: two measurements (Before and After)	Medium	Low	Low	Process evaluation	Good	Low
Time series design (Prior trend vs. Actual)	Relatively low, if feasible	Medium	Medium	Impact evaluation	Very good	Medium
Case study with one measurement and a control group (with and without)	Medium	Low	Low	Formative evaluation	Low	Low
Quasi-experimental design	Relatively high (variable)	Relatively high (variable)	Relatively high	Impact evaluation	Very good	Good (variable)
Experimental design	Expensive			Evaluation research	Very good	Very good

Source: Imboden (1978)

management and monitoring staff. Several issues are of paramount importance in the design of a monitoring system (Kupfuma & Anandajayasekeram, 1995):

- **It should be participatory**. The process should involve all levels of management and a wide range of interested parties and potential users of the program/project services and inputs. Their involvement is necessary to determine the information requirements and to ensure that important elements are taken into account. This in turn allows for improved and widespread use of the outputs of the monitoring information system. Due to cost considerations, it is necessary to agree on what information will be feasible to collect. In addition, the interaction of information users and system designers helps in the determination of the users' needs and their prioritisation.

- **Project components should be specified and prioritised.** These include short- and long-term project objectives with a view to determine targets, beneficiaries and the critical activities that should be monitored against set targets. The latter should be quantifiable, verifiable and expressed on the basis of the intended beneficiaries. Both project objectives and targets are usually set out in the initial appraisal and planning documents. The logical framework approach (LFA) is a useful way of expressing the project objectives and targets in hierarchical categories.

- **Existing information sources should be exploited.** In view of the scarcity of monitoring resources, existing information systems should be fully exploited and/or strengthened first. This could minimise the need for additional data collection. There are generally two types of information systems that could be in existence before project implementation:

    - Formal or informal internal systems of information flows and dissemination maintained by agencies involved in the activity. Some of these systems may need to be modified to meet the needs of project managers;
    - Various secondary sources, such as governmental statistical departments and M&E units; and studies undertaken by other research institutions.

    A review of the existing information systems will determine the scope and scale of the newly designed M&E system.

- **Location of the unit.** Monitoring should be integrated into a project system. The latter differs between countries, but is often hierarchical. In this case a unit often serves the needs of higher level of management and runs the risk of being perceived as a surveillance of that level of management.

Projects may also be implemented by different agencies, each with their own monitoring unit, which can cause problems in co-ordination. To resolve these difficulties, it is necessary to identify the level of management that is directly responsible for the planning, execution and control of the project. The monitoring unit should be located at this level or at those levels allowing the responsible managers ready access to information generated by the unit. The unit should therefore be close enough to the decision-making level on project execution.

Given its expansive horizons, evaluation is not necessarily an integral part of project management as monitoring is. These responsibilities can be given to units that are not an integral part of project management, because the use of evaluation as a project management tool is more limited (Kupfuma & Anandajayasekeram, 1995). However, the functions have in common the need to use resources more effectively and efficiently. This dictates that evaluation responsibilities are often assigned to units also responsible for monitoring. Evaluation can benefit project management as long as the data needs are relevant to the project. This is especially true for midterm evaluation, whose findings and recommendations can be used by managers to improve the implementation and strategies of the program/project.

- **Structure and resources of the unit**. This is closely related to its location. Once this has been decided, staff requirements should be specified in terms of reporting responsibility and discipline competencies (for example biological versus social scientists). General guidelines are that the team should be multi-disciplinary, lean and competent, with the emphasis on practical orientation. The team should include support for both field work and data entry and processing. For support staff to be continually employed, they should be able to handle both fieldwork and data processing. The procurement or availability of data processing, storage and retrieval equipment should be considered at the design stage of the unit. Mechanisms have to be in place to enable the team to disseminate their findings to managers in a timely fashion and in formats that are simple and easy. Complicated and voluminous reports are rarely read by busy managers and their findings and recommendations never considered.

Follow-Up Diagnostic Studies for Monitoring

Follow-up diagnostic studies for monitoring are based on problems emerging during implementation of the project. There is a need to study these problems in order to identify contributing factors, so that solutions grounded in empirical data may be proposed. Diagnostic studies should be used like surgical tools. They should be specifically aimed at producing empirical information that is useful in solving problems identified by managers with the assistance of the Management Information System (MIS.)

Diagnosing and solving problems

According to management experts, there are three approaches to problem solving: intuitive, judgmental, and analytical.

Intuitive

Managers who solve problems on the basis of their hunches, i.e., their “gut feelings,” are taking an intuitive approach. The major limitations to this approach are:

- Only a few managers have good enough intuition to be consistently successful in solving problems. There is no way to predict who has such exceptional intuition, and who does not; and
- This approach can interfere with the requirements to achieve a coordinated, consensual approach in a project with a complex management structure that involves several agencies.

Judgmental

Managers who base their actions on their subjective experience or knowledge are being judgmental, i.e., current actions are based on solutions that worked well before. This approach is:

- Quick and inexpensive; and
- Very little need to collect fresh data or hold time-consuming discussions.

The major disadvantage to this approach is that two situations may look similar, but may have different causes. Therefore, the manager may be let down in unusual cases.

Analytical Approach

The analytical approach gives the managers the widest and most (useful) reliable range of tools to solve problems. Scientifically valid methods allow them to study problems, understand their causes, and evaluate alternative solutions using well-defined criteria. M&E is an analytical approach to diagnose and solve management problems in a systematic manner.

Data Collection, Processing and Presentation

Four basic means of data collection exist for the M&E of programs and projects:

- Existing statistics;
- Project reports;
- Special data collection efforts. These usually consist of a baseline survey to determine the situation at the beginning of the project; re-surveys of the communities of the baseline study usually at mid-term and end of project; or special topic surveys to analyse specific problems that have occurred during the execution of the project; and
- Ratings by experts.

Communicating Information

One of the greatest weaknesses of management information systems has been the lack of effective and timely communication of information to their users. A principal part of the monitoring function is to convey information to managers in a timely fashion and in a form that can be easily understood.

There are clear distinctions among the findings revealed by the data in a MIS, the logical interpretations that follow these findings, and recommendations for action.

Findings indicate empirical results. They may constitute the basic presentation of the salient facts in the data set.

Interpretations are grounded in empirical evidence, but require certain deductions to be made based on this evidence. Confidence in these interpretations will depend on the validity of the data set, and the deductive ability of the interpreter. Interpreting the findings may require familiarity with more formal analytical tools.

Recommendations consist of proposed courses of action based on the interpretation of the findings.

Certain principles must be followed in order to improve the chances that information will be reviewed, understood, and acted upon. These principles include (Casely and Kumar, 1987):

- A presentation designed for the targeted audience;
- Timeliness;
- Credibility of material presented; and
- Brevity and clarity.

Targeted Audience: The targeted audience is the group/individuals to who the material is addressed. Interest and consensus of the recipients are not necessarily identical. Therefore, information should be targeted to meet the distinctive needs of the specific audience.

Timeliness: To get the maximum benefit from monitoring, information should be provided at the correct time.

Credibility: Credibility of the findings and the interpretations based on them is very important.

Brevity and Clarity: Brevity and clarity of presentation aids to information transfer. Communications that are not understood are no better than no communication. If brevity is the soul of understanding, then clarity is its heart.

Modes of communication can be:

- Written reports:
- Verbal presentations:
- Visual displays; and

- Combination of the above.

In presenting recommendations, a clear distinction should be made between core and peripheral recommendations. The former deals directly with the central questions, whereas the latter deals with secondary issues that emerged in the course of the study or in the analysis of the data.

Setting Up a M&E System for a Specific Program or Project

Measurement of the program toward long-term objectives is more difficult because data on socio-economic variables must be collected.

Managers often require information to assess short-term objectives. Short-term objectives are measured by the achievement of targets. The targets must be expressed with reference to the intended beneficiary. The figure in Box 20.1 shows the aspects to be considered when setting up an M&E system for a specific program or project. The left column shows the analytical steps to be followed, while the right column shows the expected products. The three major analytical steps include:

- **Specification of the program.** This involves definition of the goal and yardsticks of the program/project, as well as its elements and their logic. The major products at this stage include the goal matrix, objectively verifiable indicators, process and input variables, and hypotheses. The actions taken during this step should result in an evaluable model of the program/project.
- **Critical analysis of the project's logic.** This comprises the assessment of the project performance network and analysis of risk and uncertainty. This step should yield lists of the critical variables and the high risk variables of the program/project. A feasible model for program/project M&E should be the end result.
- **Critical analysis of the evaluation framework.** This involves discussion of the design with program/project management; analysis of the use of the information; and analysis of the costs and benefits of the evaluation design. The products include an accepted evaluation framework, the type of evaluation required, and a cost effective evaluation framework. At the end of these three steps, the practical model for program/project M&E should be ready for use.

Key Points to Consider in Establishing an M&E System for Research

Some key points to be considered in establishing an M&E system for research are:

- M&E is a means to an end. It costs money and time. Therefore, each NARS or institute should determine its own requirement for M&E, and develop a system which responds to these needs.
- Identifying the priority users is the first step in designing an information system, i.e. answer the question: *who needs the information?*
- Identify the user's needs, i.e., what type of information is needed, and for what purpose?
    - Identify project objectives, target population, critical activities, and tasks to be monitored;
    - Distinguish between the short-term and long-term project objectives and information needs for M&E including impact assessment if considered necessary;
    - In view of limited resources in terms of staff, money, and time, the requirements of all users are unlikely to be fully and effectively met by the information system. Therefore, carefully assess the needs of primary information consumers;
    - Measurement of the program toward long-term objectives is more difficult because data on socio-economic variables must be collected.
    - Managers often require information to assess short-term objectives. Short-term objectives are measured by the achievement of targets. The targets must be expressed with reference to the intended beneficiary; and

Box 20.1: Setting Up a Monitoring/Evaluation System for a Specific Program or Project

Analytical Steps		Products
1. Specification of program		
Goal specification	→	Goal matrix
Definition of yardsticks	→	Objectively verifiable indicators
Specification of program elements	→	Determination of process and input variables
Specification of program logic	→	Determination of hypotheses
↓ The evaluable model of the project		
2. Critical analysis of the project's logic:		
Project performance network	→	List of critical variables
Risk and uncertainty analysis	→	List of high-risk variables
↓ The feasible model for project monitoring/evaluation		
3. Critical analysis of the evaluation framework:		
Discussion of evaluation design with project management	→	Accepted evaluation framework
Analysis of use of information	→	Type of evaluations required
Analysis of costs and benefits of evaluation design	→	Cost-effective evaluation framework
↓ The practical model for project monitoring/evaluation		

Source: Imboden (1978)

- Specification and prioritisation of project objectives, both short-term and long-term, with a view to determine project targets, targeted beneficiaries, and the critical activities, should be monitored against set targets. Particularly important is the specification of the project targets to ensure that the established targets are quantifiable, verifiable, and expressed on the basis of the intended beneficiaries. Both project objectives and targets are normally set out in the initial project appraisal and planning documents. The logical framework is a way to express the project objectives and targets in a hierarchical way, and is dealt in detail in another section of this sourcebook.

- For monitoring information systems, short-term objectives are the major focus. The list of short-term objectives and their order of priority may be subject to modification as factors exogenous to the project change during the implementation process. The project targets may also be changed as the implementation of the project progresses. The design of the monitoring information system before the project and during implementation should be guided by the realisation that monitoring resources are limited and that the project objectives and targets are not of the same importance. As a result, the project objectives and targets should be ranked and prioritised so that higher priority objectives and targets are adequately addressed first.

- M&E is used at different levels of management for different purposes. In general, three important aspects of research are to be evaluated: performance, quality, and relevance. Questions that need to be asked are:

  - ➢ Which aspects of research are weakest in the organisation, i.e., performance monitoring, quality control, or relevance of research?
  - ➢ Is research planning at all levels sufficient to provide clear objectives and targets?
    - → The relevance of research can only be determined if its objectives are clearly stated and relate to greater development objectives. Likewise, evaluation cannot check performance against objectives if these objectives are poorly defined.
    - → At each level of research management, the objectives must be explicit.
  - ➢ Are M&E procedures necessary?
    - → What are the shortcomings of the process?
    - → Is a more formal approach needed?
    - → Sometimes the M&E system is not the problem, i.e., management may receive adequate information to apply remedial actions, yet fail to act because of lack of management skills, resources, authority, etc. In such cases nothing is gained by establishing a more elaborate system.

- There is a distinction between information required from project/research managers and information needed by project/research managers. Both need to be addressed in developing a management information system.

- Review the existing management information system to ensure optimal use of available information before undertaking any new data collection. This is needed in order to ensure that existing information systems are fully exploited and/or strengthened, thus minimising additional data collection. There are two types of information systems that could be in existence before the project is implemented. The existing information systems could be formal or informal. Internal systems of information flows and dissemination that are maintained by agencies that are involved in the execution of, or somehow related to, the project. However, some of these internal formal and informal systems may need to be modified to meet the needs of project managers. The other type of information system exiting prior to the initiation of the project includes a wide range of secondary sources such as the governmental statistical departments, government departments statistical and monitoring and evaluation units, and studies undertaken by other research institutions such as universities. A review of the existing information systems will determine the scope and scale of the newly designed monitoring information system.

- Information costs money and objectives of the project are not all of equal importance. The information system must ensure that the priority objectives are fully accommodated if necessary at the expense of those considered secondary.

- Basic questions needed to be answered in determining information needs are:
  - ➢ What are the minimum information requirements for effective management of the activity?
  - ➢ What are the timing requirements for each information item?
  - ➢ In what form should the information be collected?
  - ➢ What method would be used to collect the information identified?
  - ➢ Who will be responsible for collecting, storing, and managing such information?
  - ➢ In what form should the information be conveyed?
  - ➢ How will the information be used?

- A conceptual framework assembled by outside experts should not be used to identify information needs.
- As much as possible, improve the existing system by adopting and supplementing them.
  - ➢ Identify who else is involved in collecting and processing of data, e.g., national statistical office, planning commission, etc.;
  - ➢ What data and reporting are currently required?
  - ➢ How well it is accomplished? and
  - ➢ What additional data reporting is necessary?

  The functions of the system should be agreed upon by the people using it as well as those implementing it.

- What indicators are needed to do the job?
  - ➢ Once objectives have been defined, verifiable indicators of achievement must be selected and the methods of measurement determined;

- ➢ Choice of indicators determines the data, types of people needed to monitor them, and cost of M&E ; and
- ➢ Both logical framework approach (to identify objectively verifiable indicators) and PIM approach (to identify subjective indicators) should be used to identify indicators.

Remember: collecting irrelevant data is costly and will also complicate the analysis later on.

- In determining the data collection strategy, adequate consideration should be given to the available resources, cost, and time involved. There may be a need to use proxy measures to measure the progress toward long-term objectives. Unless data gathering, analysis, reporting of information, and subsequent action is going to be timely, then there is little point in setting up an M&E system at all. The same questions that need to be addressed are:
  - ➢ Are personnel and funds available to do the M&E work?
  - ➢ Is there a need for separate M&E unit?
    - → The evaluation function is often combined with a responsibility for programming future activities, in a planning and evaluation unit;
    - → Need for a special unit depends on:
      - Types of evaluation deemed to be necessary; and
      - Quantity and the type of information required. Extensive and specialized data may be needed to perform detailed economic analysis, notably for impact evaluation;
    - → The unit should have a service orientation; and M&E may be better accepted by researchers if it is perceived as an internal activity, conducted by fellow researchers who are sympathetic to the special nature of research.
  - ➢ How much does M&E cost?
    - → Cost depends upon:
      - Services required;
      - The extensiveness of data collection and analysis;
      - Available national resources in terms of expertise; and
      - Whether external assistance is needed.
    - → Costs include:
      - Direct costs of the evaluation staff;
      - Costs of travel;
      - Costs of coordinating and tabulating data; and
      - Preparation of the evaluation report.
  - ➢ What are the simplest means possible of collecting the necessary data? Can they be obtained from existing resources? If not available, can they be collected at reasonable cost in relation to their usefulness?
- Ensure that the design process is a participatory one in which all levels of project management and a wide range of interested parties and potential users of project services and inputs are actively involved. Their involvement is necessary in the determination of information requirements given that due to cost considerations, it is not feasible to collect all of the information that project management and other users may deem relevant. This ensures that all important elements from all viewpoints are taken into account as well as allows for better and widespread use of outputs of the monitoring information system. In addition, the interaction of information users and system designers helps in the determination of the users' needs and their prioritisation.
- Organising a project on the basis of cost centres is fundamental for cost accounting. Cost accounting is different from traditional financial accounting in that it is an internal management tool, whereas financial accounting basically meets the needs of external reporting. Cost accounting describes the relationship between costs incurred on inputs, other resources, and materials for specific activities and the planned outputs and services from those activities.
- Another issue to be considered is the location of the monitoring (and evaluation) unit. The main consideration is to ensure that monitoring is integrated into a project management that is often hierarchical. In a hierarchical management system, a monitoring unit serving the needs of higher-level managers runs the risk of being seen as a surveillance arm of that level of management. The project may also be implemented by a number of different agencies such that each agency having its own monitoring unit may pose problems of co-ordination. To resolve these difficulties, it is necessary to identify the level of management that is directly responsible for the planning, execution, and control of the project. The monitoring system should be designed to serve the

information needs of this level of management. The monitoring unit should be located at this level or at those other levels which allow the managers responsible for project execution to effectively use the information generated by the monitoring unit. In other words, the unit should be close enough to the decision making level on project execution.

Although agricultural research management structures differ from one country to another, they are all hierarchical. The top management level is usually the directorate consisting of the Director of Research and several deputies and/or assistants. This level does not execute research programs/projects. It is involved in planning and research policy. The management level that is involved in the implementation of research projects are the heads of stations and commodity research teams. A monitoring and evaluation unit should work at this level. If the unit is located at the directorate level, there is a risk that it may be seen as a means for the directorate to evaluate the different research managers. The problem is that cost considerations do not allow for each research station or commodity research team to have its own M&E unit. Hence, the unit is centrally located for the purpose of minimising costs. The unit should serve the needs of the heads of research stations and commodity research teams and the reporting structure for the unit should reflect this. The information should be collected by the individual researcher/research team and fed back to the central unit. In order to avoid duplication of efforts, the control unit should identify the other institutions/organisations involved in collecting similar data and establish mechanisms to access such information. Although a control unit is desirable for cost considerations, effective functioning, and management, it may require some basic data to be kept with the heads of stations and commodity research teams. With the advent of micro computers, this may not be a major problem.

- The other consideration related to the location of the monitoring unit is the structure of the unit and the resource requirements to effectively carry out these functions. Once the location of the unit has been decided, staff requirements should be specified in terms of size, reporting responsibilities, and disciplinary team (biological versus social scientists) composition. The general guidelines are that the team should be multi-disciplinary, lean and compact, and that the emphasis should be on practical orientation. The team should include support staff for fieldwork, data entry, and processing. For support staff to be continuously employed, they should be able to handle both field work and data processing. To facilitate the activities of the monitoring unit, consideration should be given, at the design stage, to the procurement or availability of data processing, storage and retrieval equipment. Finally, a mechanism must be in place to enable the team to disseminate their findings to project managers in a timely fashion and in formats that are simple and easy for busy managers. Complicated and voluminous reports are rarely read by busy project managers and their findings and recommendations are never considered.
- Adequate consideration should be given to data storage, processing, and retrieval requirements.

KEY REFERENCE

Imboden, N. (1978) *A Management Approach to Project Appraisal and Evaluation: with special non-directly productive projects*. Development Center Studies. Paris: OECD.

PART IV *IMPACT ASSESSMENT METHODS*

For those who invest in agriculture, their ultimate interest is the extent to which their investments eventually bears a positive outcome on the lives of poor and hungry people of the developing nations. Impact assessment has therefore become a major step in the strategies of most donors, governments and private financiers of research. Impact assessment of R&D has faced several challenges and in turn it has provided new opportunities. The challenges lie in the area of measurement where a balance has to be sought between low-cost approaches, which rely on limited collection of primary data, and the use of highly rigorous and data intensive approaches, which can be quite costly. Since there is no single correct answer to this dilemma, a starting point maybe that both costly and low cost approaches can produce accurate and also inaccurate assessments. The selection of such methods should therefore be on a case-by-case basis depending on the complexity of the program and the resources available, both financial and technical. The opportunity provided by impact assessment is allowing scientific organisations to focus on people and what benefits science ultimately offers to poor and hungry people. In the past research organisations did not concern themselves directly with such impact issues.

In Part IV of the Sourcebook, a wide array of R&D impact assessment methods are discussed, ranging from the simple to complex and from the data-hungry to qualitative methods of the strategies for impact assessment. This part of the sourcebook confines discussion to ex-post assessment methods, that is evaluation after several years of program implementation, in particular at the points of maturity and/or completion.

Chapter 21 sets the context by looking as various strategies that impact on the capacity to measure and dwells on the issues of data collection. The importance of having either 'cross-sectional' or 'time-series' data is discussed here. An overview of the method is outlined in Chapter 22.

Chapter 23 covers some of the most rigorous methods and some of the most widely used approaches for economic impact assessment. The 'economic surplus approaches' require a considerable amount of technical expertise and data. Chapters 23 and 24 cover methods that are being used to a varying degree and with different level of rigour. These include respectively the Cost saving method, the Index Number method and the Production Function approach.

The last three Chapters in this Part discuss important issues which are often of interest to those decision makers who sponsor research and its impact assessment. The issue of spill-overs is discussed in Chapter 25 and the main point here is the recognition that R&D's impacts often go beyond intended physical, economic and technological boundaries. It is therefore important to deal which such spill-overs in applying impact assessment tools. The issue of research impacts on the environment is today such an obvious hot topic and this is covered in Chapter 26. Once again the issue of participation is covered in Chapter 27. Increasingly policymakers and donors are also very concerned about organisational performance. The issues and approaches for Organisational Performance Assessment are addressed in Chapter 28.

In conclusion, the reader is reminded that donors, financiers and beneficiary stakeholders are ultimately interested in ex-post impact of their investments. The reader may not have all the technical expertise for each method discussed, but the important thing is to be familiar, and to remember that most of the time the application of such methods requires a team of people and that is the point at which people with requisite expertise are recruited for the task. In addition, the importance of topical issues such as the environment and participation are still paramount whatever methods are used.

STRATEGIES FOR IMPACT ASSESSMENT

Introduction

Impact assessment is directed at establishing, with as much certainty as possible, whether or not an intervention is producing its intended effects. To minimise errors in conclusions, impact evaluation needs to be undertaken as systematically and as rigorously as possible. Outcomes of social programs are assessed by comparing information about participants and non-participants, before and after the interventions. Essential considerations involve the systematic rejection of alternative, compelling explanations for the observed outcomes other than intervention. The concepts of gross outcome, net outcome and confounding factors are discussed in this chapter. Some of the design considerations with respect to impact studies are also discussed.

Pre-requisites for Assessing the Impact (*Ex-Post*) of an Intervention

The project should have its objectives sufficiently well articulated to make it possible to identify measures of goal achievement or the evaluator must establish objectives. The intervention should have been sufficiently well implemented for there to be no question that its critical elements have been delivered to appropriate targets. Goals must be specified before impact assessment can be undertaken. There is a need to establish that the program is the 'cause' of some specified effect.

The starting point of an impact assessment is the identification of one or more outcome measures that represent the objectives of the program.

Gross Outcome and Net Change

Gross outcomes are changes in an outcome measure that are observed after a program has been operating. Net outcomes are those results attributable to the intervention, free and clear of the effect of other causes in the program's context.

$$\text{Gross Outcome} = \begin{bmatrix} \text{Effect of Intervention} \\ \text{or Net Outcome} \end{bmatrix} + \begin{bmatrix} \text{Effects of Confounding} \\ \text{Factors} \end{bmatrix}$$

Impact assessment must arrive at estimates of net intervention effects.

Confounding Factors

Confounding factors are the extraneous 'causes' that compete with intervention efforts to explain changes in the target problem or population after the program has been put into operation.

Endogenous changes

Social programs operate in environments in which ordinary or "natural" sequences of events influence outcomes, e.g., a program to reduce poverty has to consider that some families and individuals will become economically better off without help from the project.

Secular drift

Relatively long-term trends in the community or country in question may produce changes that enhance or mask the effects of a program. For example:

- Communities birth rate declining generally, a program to reduce fertility in that community may appear to be effective because fertility trends are generally downward;
- A program to upgrade housing quality may appear to be effective mainly because the national trends in real income enable everyone to put more resources into their housing; and
- A project to increase crop yields may appear to fail because weather conditions lead to poor sowing conditions during the program period.

Interfering events

Like long-term secular trends, short-term events may produce enhancing or masking changes. Examples of enhancing or masking changes are:

- Disruptions in communications - interfere with the delivery system may make the delivery of food supplements difficult, may interfere with the nutritional program, input delivery, etc.; and
- The threat of war, strikes, civil unrest, etc.

Self selection

Perhaps the most serious obstruction to assessment of the intervention's impact is the fact that the portions of a target population easiest to reach are usually also those most likely to change in the desired direction, because targets differential potential to change. Clearly projects based on the voluntary cooperation of individual households or other units are most likely to be affected by self-selection process. Such persons are likely to manage to improve their skills whether or not they enrol in a project. When the participation is as a result of political or administrative action, the situation may be different.

Drop out rates varies from project to project, but are almost always disturbingly significant. Individuals that leave programs may be different in quite understandable ways from those who remain throughout. For one thing, those who are clearly benefiting from the intervention are likely to remain or be encouraged to do so, while those who find the project unrewarding or difficult are likely to drop out or be discouraged from remaining in the program.

The extraneous confounding factors listed above are those to which an evaluator must be particularly alert in designing impact assessment research. The confounding factors are neither equally nor uniformly distributed across all impact evaluations. They are present or absent depending on the substantive area involved.

Measurement Error

Measurement errors are always present. The two most prevalent measurement errors are stochastic effects and unreliability.

Stochastic effects

In any measurement efforts, chance or random fluctuations (due to the stochastic nature of the processes), may make it difficult to judge whether a given outcome is large enough to warrant attention. Each set of observations is a sample from a target population or from all possible trials of the project. Given a large number of samples drawn with probability methods, sampling theory applied appropriately describes how much variation one can expect, and how often one can expect a variation of a particular size.

Applying the results of appropriate statistical tests, one can judge how often a given result would occur by chance alone, even though the true outcome is zero. Thus, a given effect, say a 5 percent difference in crop yield for farmers who have adopted a new fertiliser, may turn out to be a highly unlikely outcome for a program in which the "true" effect is zero. The statistical significance of a particular outcome is estimated by comparing it with what would be expected by chance when sampling from a hypothetical set of trials in which the "true" effect is zero.

Unreliability

Data collection procedures are always subject to a certain degree of unreliability. The reliability of a measure is defined as the degree to which identical scores or values would be obtained on a measure in repeated data collection efforts with the same population.

A major source of unreliability is the measurement instrument itself. The testing or measuring situation, observer or interviewer's reliability and even subjects' mood swings also contribute to unreliability. The more unreliable a measure, the larger the actual real differences must be to indicate a significant result.

A Formula for Impact Assessment

A generalised formula for impact assessment is as follows:

$$\text{Net Effect} = [\text{Gross Outcome}] - \begin{bmatrix} \text{Endogenous Change} \\ \text{Secular Drift} \\ \text{Interfering Events} \\ \text{Self Selection} \\ \text{Unreliability Effects} \end{bmatrix} \pm [\text{Stochastic Effects}]$$

Design Options for Impact Assessment

The strategic issue in impact assessment is how to obtain estimates of what would be the difference between two conditions, one in which the intervention is present, and one in which it is absent. There are several alternative approaches that vary in effectiveness. All involve the establishment of "controls." For example:

- Randomised Controls. Targets are randomly divided into an experimental group, to whom the intervention is administered, and "randomised control" from whom the intervention is withheld;
- Constructed Controls. Targets to whom the intervention is given are matched with an "equivalent" group, constructed controls from whom the intervention is withheld;
- Statistical Controls. Participant and non-participant targets are compared, holding constant statistical differences between participants and nonparticipants;
- Reflexive Controls. Targets who receive the intervention are compared with themselves, as measured before the intervention;
- Generic Controls. Intervention effects among targets are compared with established norms about typical changes occurring in the target population; and
- Shadow Controls. Targets who receive the intervention are compared with the judgements of experts, program administrators, and/or participants on what changes are "ordinarily to be expected" for the target population.

It is important to note that the alternatives listed above are not mutually exclusive. Randomised controls may be compared with experimental groups, and statistical controls may be used a well. Constructed controls and statistical controls at the margin are difficult to distinguish from each other in practice.

The most severe restriction on strategy is whether or not the intervention in question is being delivered to all (or virtually all) members of a target population. Here it is not possible to define a control group. In such circumstances, the main strategy available is the use of reflexive controls and before and after comparisons.

In contrast, interventions that are to be tested on a demonstration basis ordinarily will not be delivered to all of the target population. Hence, in the start-up plan, new programs are, almost by definition, programs with partial coverage. In all likelihood, no program has ever achieved true coverage of its intended target population. For example:

- Some refuse to participate;
- Some are not aware that they can participate; and
- Some are ineligible on technicalities.

As a rule of thumb, when programs reach 80 percent coverage, it program could be considered as having achieved "full coverage."

Data Collection Points

There are numerous data collection points for a project/program. However, the two primary data collection designs are:

- Longitudinal Designs: Longitudinal designs are those in which at least two observations are made, one before and one after the intervention has been put into place. Ideally, additional observation data points are also used; and
- After Only Designs: After only designs are those in which only one observation is made after the intervention is in place.

Most randomised experiments are designed with pre- and post-measurements of outcomes. The main reason for doing so is to hold the initial starting points of targets constant in subsequent analyses of experimental effects.

Non-randomised experiments with constructed and/or statistical controls. A large class of impact assessment designs consists of non-randomised approaches, all of which have in common a comparison between experimental groups, created out of targets who have elected (in some fashion) to participate in a program and "constructed control" groups of non-participants who are in some critical way comparable to participants. Such comparisons may be made through the construction of groups of non-participant targets.

The dividing line between non-randomised experiments with constructed controls and one-time short surveys is often obscure. The important point, however, is that the reasoning involved in both is much the same. Both approaches attempt to estimate net effects by creating control groups that presumably represent potential targets whom were unexposed to the intervention.

Cross Sectional Surveys

Cross-sectional surveys are one-time sample surveys of target populations, some of whom have not received treatment. Targets who receive the treatment are compared with those who do not on post intervention outcome measures, using statistical techniques to hold constant differences between the two groups. Although cross-sectional designs are among the expensive ways to estimate impact, they are also among the more difficult to carry out rigorously.

Time Series Analysis

Full coverage programs present especially difficult problems in impact assessment because they lack an uncovered target population that might serve as a control or yield control observations. However, if extensive, over time, before-program-enactment observations on outcome measures exist, it is possible to use the quite powerful technique of time-series analysis.

The ideas underlying them are quite simple. The trend before the treatment is analysed in order to obtain a projection of what would have happened without the intervention. The trend after the intervention is then compared with the resulting projection and statistical tests are used to determine whether or not the observed post-intervention trend is sufficiently different from the projections to infer that the treatment had an effect. The most serious limitation of this approach is that many pre-intervention observations are needed in order to model accurate pre-intervention time trends (more than 30 points in time are recommended).

Before and After Studies of Full Coverage

For many full coverage programs, long time-series data regarding before and after program enactment may not be available. Instead, only a single, before enactment measure may exist with the addition of a measure taken after the intervention has been in place. Treating both cases with appropriate caution an impact assessment can still be made. The main problems are obvious and stem from the possibility of confounding factors obscuring the impact of the program in question.

Generic and Shadow Controls

For cases requiring full coverage with constant intervention, only generic and shadow controls can be used to develop estimates of what would happen without intervention. Because no pre-intervention measure exists, no reflexive controls can be used. Since everyone is covered by the program and the program is uniform over places and time, neither randomised, nor constructed control can be used.

Generic control

Generic control consists of estimates based on studies of what ordinarily happens over time. This involves defining a norm based on historical data. Problems incurred in such methods are:

- Some of the norms are not based on very carefully conducted research; and
- Published census data may not offer information sufficient to pinpoint individuals who would be comparable to targets experiencing an intervention.

Shadow control

Shadow controls consist of the judgements of experts, program administrators or participants. While expert judgements may be sufficient in some fields, precise knowledge of the sort needed is not ordinarily available for most crucial programs even to the most experienced experts.

Generic and shadow controls are the only controls available for full coverage, uniform programs for which no pre-intervention measure exists. Generic and shadow control estimates are relatively inexpensive and take little time. As such, there is a temptation to use them. However, they are recommended only as a last resort.

Data for Impact Assessment

Types of data that are useful for conducting impact assessments are quantitative, and/or qualitative. Quantitative data can be defined as observations that readily lend themselves to numerical representations. Qualitative data, in general, are less easily summarised in numerical form.

These distinctions are obviously not hard and fast. The dividing line between the two types of data is fussy. Qualitative data may be transformed into quantitative data by content analysis, while quantitative data may be treated as qualitative data by disregarding the numerical values, i.e. treating each interview schedule as a unit instead.

Qualitative observations have extremely important roles to play in certain types of evaluative activities particularly in the monitoring of ongoing programs, but difficult and expensive to use.

Assessing impact in ways that are scientifically plausible, and that yield relatively precise estimates of net effects, require data that is quantifiable, and systematically and uniformly collected. Outcome measures should be reliable and valid. In order to have any worth, and impact assessment must meet the requirements of both.

A measure is valid to the extent that it measures what is intended and presumed to measure. While the concept of validity is easy to comprehend, it is difficult to test whether a particular instrument is valid. For example, the validity of a measure of willingness to take business risks, if formulated as an attitude scale, would require a validity test on some behavioural measure of the extent to which an individual is willing to take actions that might be profitable, but also involve a good deal of risk. In practice, there are a number of ways such attitudes can be measured. If there was one way or a small number of ways that everyone could accept as the "best" methods of measuring risk taking, then potential measures could be compared with the "best" method. However, in the absence of a best measure, the question of whether a particular measure or set of measures is valid is usually a case-by-case argument.

A valid measure also must be reliable. However, reliability, although necessary, is an insufficient criterion of validity. In addition to validity and reliability, it should also be consistent with usage. A valid measure of a concept must be consistent with the past work that has used that concept. Hence, a measure of 'adoption of innovation" must not contradict the usual way the term "adoption" has been used in previous studies of innovation.

A valid measure should also be consistent with the alternative measures. A valid measure must be consistent with alternative measures that have been used effectively by other evaluators. It must produce roughly the same results as other measures that have been proposed, or, if different, have sound conceptual reasons for being different.

A valid measure must be internally consistent. That is, if several questions are used to measure a concept, the answers to those questions should be related to each other as if they were alternative measures of the same thing (Rossi and Freeman, 1982).

A good outcome measure is one that is feasible to employ given the constraints of time and budget and that is more or less directly related to the goals of the program, and hence, valid. For example, a family planning program should include:

- Proportion adopting effective contraceptive practices;
- Average desired number of children;
- Average number of children born to completed households; and
- Attitude toward large families.

A reduction in the average number of children born to concluded households may be the best expression of the eventual goal of fertility programs. Use implies a long-term evaluation of considerable complexity and cost.

The attitude toward large families may be easy to measure, based on the assumption that an effective fertility-reduction program is reflected in low approval of large families. Often a small erratic magnitude of the relationship between attitudes and behaviour, or a downward shift in the average desirability of large families is likely to be a remote measure of goals of a fertility-reduction program. Changes in such attitudes may often occur without a corresponding shift in fertility practices. Given the alternatives listed, shifts in contraceptive practices may be, on balance, the best choice as a measure. For example:

- Shifts in practices can be studied over relatively short periods of time;
- There are ample precedents for adequate measurements in previous research; and
- Shifts in contraceptive practices are directly related to fertility.

Proxy Measures

An outcome measure that is used as a stand-in for a goal that is not measured directly is called a proxy measure. Proxy measure should be valid and reliable. Ideally a proxy measure should be closely related to the "direct" measure of the project goal, but should also be much easier to obtain.

There are no fixed guidelines for selecting proxy measure. However, simplicity is usually the order of the day when using proxies. Several situations where proxy measures are useful are:

- Where goals and objectives are measurable in principle, but too costly to measure. Quality of jobs may be measured by some weighted combination of earnings, wage rates, steadiness or employment, working conditions or other measurable job attributes. However, several reasonable proxy measures can be employed instead of such a long and expensive procedure. Earnings and wage rates are good proxies; and

- Goals and objectives that are expected to be reached in the far future can be represented by proxy measures that are intermediate steps towards those goals, e.g., a project on family fertility is to reduce average family size:
    - Can only be measured definitely after the women in those families have passes through their childbearing years:
        - → Proxy Measures:
            - – Adoption of contraceptive practices; and
            - – Changes in expressed desired family size.
        - → "Surrogate Measures":
    - Performance of tree species based on "growth height" during the first few years.

Major Issues in Assessing Impact of R&D Activities

Impact assessment is directed at establishing, with as much certainty as possible, whether or not an intervention is producing its intended effects. The three basic issues that need to be taken care of in any empirical impact study are causality, attribution and incrementality. All these three aspects are somewhat interrelated.

Causality:

In measuring the impact of R&D investments it is important to ensure that the impact measured are al a result of the technologies and activities undertaken within the program/project. However, as one moves from the direct product to broader economic, social and environmental effects, the chain of causal events is too long and complex and the variables affecting ultimate outcomes are too numerous to permit the identification and measurement of impacts of specific interventions (Biggs,1986; House 1993; Rossi and Freeman, 1982).

Incrementality:

R&D programs operate in environment in which ordinary or 'natural' sequences of events influence outcomes, e.g., a program to reduce poverty has to consider that some families and individuals will become economically better off without the help of the project, or careful seed selection by farmers will gradually increase the yield levels even without improved varieties. Thus, it is important to make a distinction between the 'gross outcome' and 'net outcome' of interventions. Gross outcomes are changes in an outcome measure that are observed after a program has been operating. Net outcomes are those results attributable to the intervention, free and clear of the effect of other causes in the program's context.

$$\text{Gross Outcome} = \text{Effect of Intervention or Net Outcome} + \text{Effects of Confounding Factors}$$

Impact assessment must arrive at estimates of net intervention effects, i.e. should measure the incremental changes attributable to the intervention. The compounding factors are the extraneous 'causes' that compete with intervention efforts to explain changes in the target problem or population after the program has been put into operation. Thus, in measuring the impact an analyst must pay attention to endogenous changes, secular drifts (long term trends), interfering events (short term events), self-selection, stochastic effects as well as unreliability effects.

In the literature one could identify three different types of comparisons: 'Before' and 'after comparisons'; 'with' and 'without' comparisons; and 'target' vs. 'actual' comparison.

The 'before' and 'after' (also referred to as historical comparison) comparison fails to account for changes in production and other outcomes that would occur without the project, thus, leading to an erroneous statement of the benefit attributable to the project investment.

Consider a situation where the production in the area is already growing, but only slowly and probably will continue to grow during the life of the project. The objective of the project is to increase growth by intensifying production. In this situation, if the analyst had simply compared the output before and after the project, (s)he would have erroneously attributed the total increase in production to the investment. However, what can be attributed to the project investment is only the incremental increase in production that would have occurred as a result of intervention.

'With' and 'without' comparison is the most appropriate measure as it accounts for the other endogenous changes. This is almost like a controlled experiment, but is difficult to achieve in real world. However, it is important to specify the 'with' and 'without' scenario very clearly to avoid wrong estimation of benefits.

Since it is difficult to actually simulate the 'with' and 'without' scenario a comparison is very often made between a 'target' set at the time of planning and the 'actual' realised at the end of the project. A logical framework approach once again can assist in the process. Here the challenge is to set realistic, measurable, quantified targets at the time of planning.

Attribution

The attribution problem arises when one believes, or tries to claim that a program has resulted in certain outcomes and alternative plausible explanations exist. The more obvious these factors are, the less credible is the performance or impact information. John Mayne (1995) suggested a number of strategies that can be used to address attribution through performance measurement. Collectively these are elements of a contribution analysis process. The various elements of the contribution analysis are in Box 21.1 and discussed in the following sections.

Box 21.1: Steps in Contribution Analysis

Contribution analysis: Addressing Attribution with Performance Measures.

- Acknowledge the problem
- Present the logic of the program
- Identify and document behavioural changes
- Use discriminating indicators
- Track performance over time
- Discuss and test alternative explanations
- Gather multiple lines of evidence
- When required, refer to the need for an evaluation

Acknowledge the Problem:

The first step in contribution analysis is simply acknowledging that there are other factors at play in addition to the program and that it is therefore usually not immediately clear what effect the program has had, or is having in producing the outcome in question. Acknowledging the other factors at play is more honest and hence more credible than pretending they do not exist.

Analyse and Present the Logic of the Program

There is some logical reasoning behind the program that explains what it is supposed to accomplish and how. A logic chart for the program tries to display on a page how the program is supposed to work, how the various outputs of the program are believed to produce a number of results that will lead to the intended final outcome of the program. Logic charts can also discuss the key external factors influencing outcome.

A logical framework used in the planning process can be effectively used for this purpose. Figure 21.1 illustrates in a generic fashion what a logic chart can look like and Figure 21.2is a specific logic chart for a training related project. Note that the logic chart:

- Illustrates the linkages between specific outputs, specific intermediate outcomes and specific end outcomes.
- Explicitly include the idea of reach (who the program is expected to reach) and immediate outcomes. It is often at these levels in the results chain that the performance indicators can do a good job of measuring, and it is at this level that the program typically has most control. The evidence that the intended immediate outcomes have in fact occurred is a critical step in demonstrating the larger performance and impact story.

Developing and using a logic chart has a number of benefits for program managers, such as developing consensus on what the program is trying to accomplish, developing an understanding on how it is believed to be working, clearly identifying the clients of the program, seeking and getting agreement on precisely what results are intended and identifying key measures of performance. One is also interested in the additional benefits of identifying

- The cause-effect relationships implicit in the program's theory
- The outside factors at play; and
- Areas where understanding about the impact of the program is weak.

If significant outside factors are identified as possibly having an effect on the intended outcome, then evidence to refute, or to determine the extent of influence of those claims will be useful in addressing the attribution question. As mentioned earlier a logical framework included in most of the project proposals can be extended to accommodate some of the aspects identified here.

Figure 21.1: A Program Logic Chart

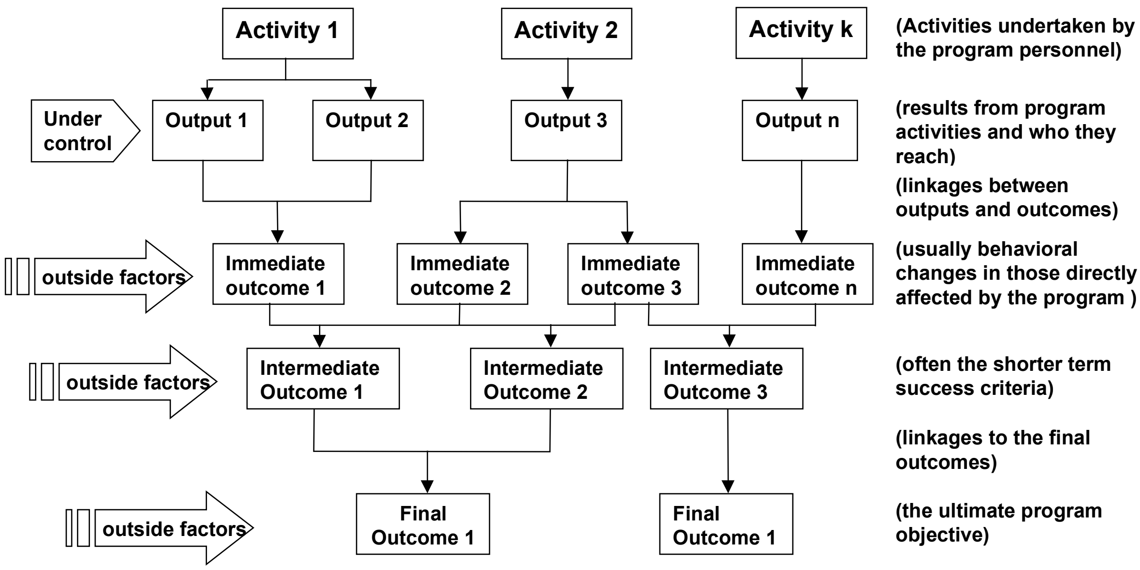
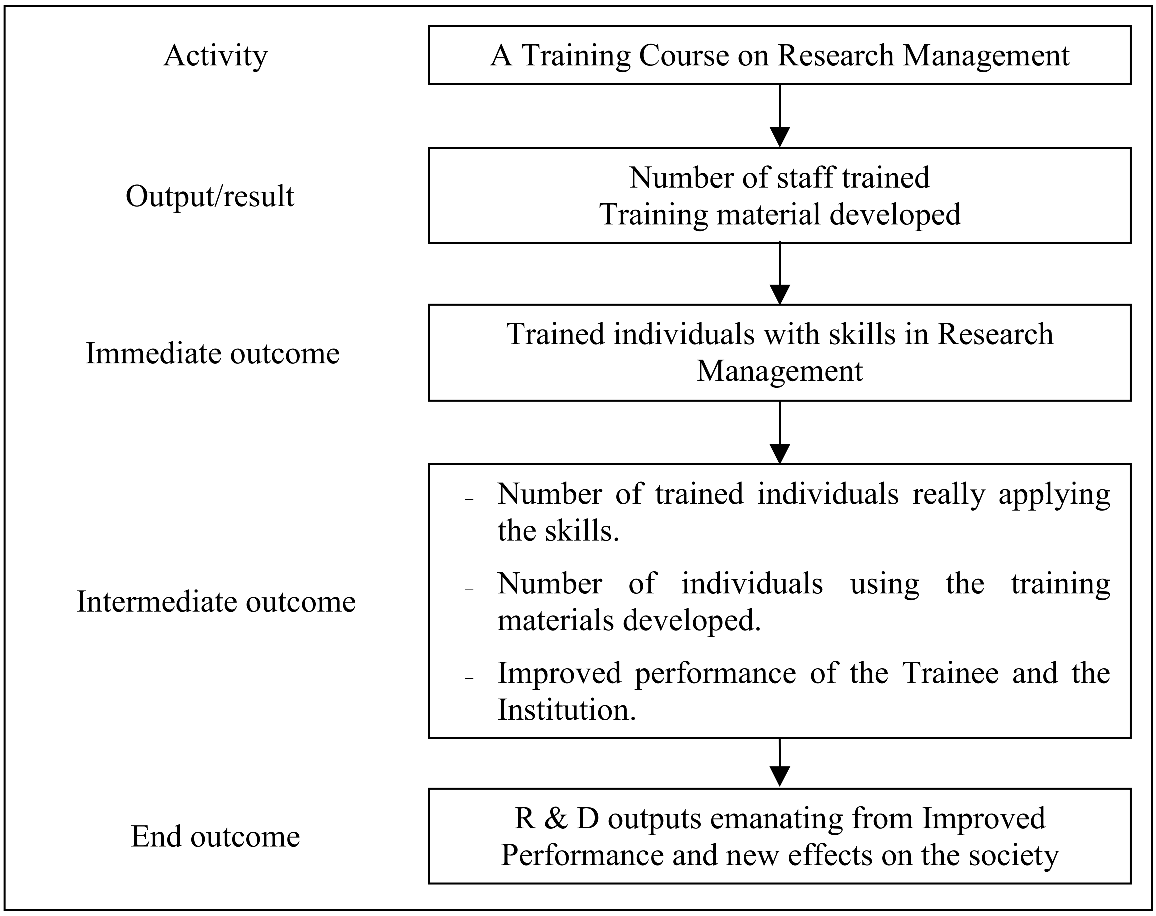


Figure 21.2: Logical Chart for a Training Project



Identify, measure and Document Expected Behavioural Changes

In order to bring about an outcome, programs have to change people's behaviour. By trying to identify and then document the changes in attitudes, knowledge, perceptions and decisions taken by program target groups - which logically link to the outcomes being observed - a good understanding of the actual impact the program is having can often be acquired. This, of course, requires clearly identifying who the various clients of the program are and how their behaviour is expected to change. If one could observe these short term changes occurring, the logical case for the program's attribution can be enhanced.

Use Discriminating indicators

In assessing programs, considerable care is needed in selecting indicators of performance. Here, we are considering the attribution issue where it is important to use performance indicators that best discriminate or focus on the outcomes in question.

Many indicators are ratios, where the denominator qualifies the numerator. Consider a program designed to reduce air accidents by inspection of the airworthiness of aircraft. An indicator might be the number of air accidents per air-miles flown. A better indicator would be the number of air accidents due to structural failure per air-mile flown. But structural failures may occur regardless of inspections. Therefore, it may be better still to use two indicators: the number of accidents per air-miles flown due to structural failure in aircraft inspected and the number of air accidents per air-mile flown due to structure failure in aircraft not inspected. By comparing structural failures in inspected and uninspected aircraft one can estimate what inspection does to reduce the problems that inspection is designed to address. Questions of attribution still exist, but the more refined indicators reduce the problem and improve the chance of providing useful information on the contribution of the program.

Tracking Performance Over Time or Location

In cases where the program activities have varied over time, showing that outcomes have varied in a consistent manner with the variation in activities can strengthen the argument that the activities have indeed made a difference. Hendricks (1996) identifies a number of such cases where by tracking performance measures we might show that:

- Outcomes appeared at an appropriate time after our efforts began;
- Outcomes appeared in different locations or with different people;
- Outcomes faded when our efforts stopped.
- Only those outcomes appeared that we should have affected;
- Outcomes appeared only where or when we were active; and
- The biggest outcomes appeared where we did the most.

In some areas of a program, such as the impacts from research activities, there is likely to be a significant delay before the intended outcomes occur and the attribution picture portrayed through tracking performance over time will not be as evident. In these cases, one still needs to track outcomes over time to see if the intended outcomes have occurred, but demonstrating or understanding attribution is even more of a challenge.

Explore and Discuss Plausible Alternative Explanations

The attribution problem arises when one believes or is trying to claim that a program has resulted in certain outcomes and there are alternative plausible explanations, i.e. there may be other reasons for the observed outcome. Dealing with these alternative explanations in a systematic way is one way of handling the attribution issue. This entails:

- Identifying the most likely alternative explanations;
- Presenting whatever evidence or argument you have to discuss and, where appropriate, discounting these alternative explanations; and
- Presenting whatever evidence there is that the program is a more likely explanation.

Gather the kind of evidence that could be used to counter arguments for alternatives to the program and its situation. Two generic types are available.

1) The logic argument. One might refer to the theory behind the program and the kind of theory that would be needed to support claims for rival hypotheses.
2) One can also bring actual evidence to bear concerning the alternative explanations.

Addressing attribution problem in this way demonstrates that:

- You are aware of the complexity of the situation
- You acknowledge and understand the other factors at play; and
- You are nevertheless concluding (assuming you are) that the most likely explanation for the observed outcome is that the program has made a significant contribution.

Unless one specifically discusses alternative explanations, simply pointing out the existence of alternative explanations can effectively challenge the program's efficacy.

Gather Additional Relevant Evidence

One might also gather evidence concerning alternative explanations of the observed outcome. The data might be part of the routine performance measurement system, but more likely would be collected from time-to-time when the analysis of the program's contribution is undertaken. Data collection might entail a review of the relevant literature, surveys, tracking of relevant external factors, field visits, or focus groups.

Additional information may be collected in a number of ways: expert opinion, structured survey, reviewing program files, secondary data analysis, including meta-analysis.

Expert Opinion:

In many situations, there are persons outside the program who are seen as knowledgeable about the program area, the program's impacts and the environment in which the program operates. A focus group of experts may be another approach that would allow some probing as to why such views are held.

Structured Survey:

A structured survey may be able to provide some evidence, albeit subjective in nature, of the extent to which the program is influencing an outcome. Surveying such individuals is often done to find out other information about the programs, in which case adding questions on attribution is not very expensive.

Program Files:

There is frequently considerable existing date available from program files; some of which might be useful to provide information on the contribution of the program. This type of existing data, which probably has been collected for other purposes, can often contain valuable information, particularly if used in conjunction with new data collected.

Available Secondary Analysis:

In other cases, there may be useful secondary analysis that the others have done in the program area that might clarify measurement and attribution issues. In still other cases, there may be Meta analysis that has been done- analysis that synthesis a number of studies in an area.

Case Studies:

One could also make use of specific case studies. It can reveal the real nature of the program and also demonstrate, at least in these cases, that one can be fairly confident about the impacts of the program's activities. This type of evidence can be quite persuasive but appropriate cautions are a must, especially when it is quite anecdotal. Case study and anecdotal evidence is best when illustrating a concrete case to complement other evidence that has been collected. On its own, however, it can be quite misleading since it may merely be one of the few cases that appear to have worked while the majority has not. Nevertheless, if the context and limitations are made clear, there is often a useful role for individual case studies.

Use Multiple Line of Evidence

The 'multiple lines of evidence' argues that while no one piece of evidence may be very convincing, a larger set of different and complementary evidence can become quite convincing. Thus, in trying to reduce uncertainly surrounding attribution, using as many lines of evidence as possible is a sensible, practical and credible strategy.

Refer to the Need for an Evaluation

If it is critical to have good information on attribution and the available evidence point in different directions, then the best strategy is to simply acknowledge that one does not know and suggest that a thorough study be carried out to address the attribution question.

In most cases, however, the program has indeed made a significant contribution and the various lines of evidence will confirm this.

Remember, what 'contribution analysis' helps us to do is to reduce the uncertainty about the contribution made and not proving the contribution made by the program. One may argue that undertaking a contribution analysis would examine and present the best case possible – a credible convincing performance story – for attribution with the available evidence.

A Credible Convincing Story has the following characteristics:

- Well-articulated presentation of the context of the program and its general aims; (presenting a plausible theory)
- Highlighting the contribution analysis indicating there is association between what the program has done and the outcomes observed and
- Pointing out that the main alternative explanations for the outcomes accruing, such as other related programs or external factors, have been ruled out or clearly have only had a limited influence.

If there are too-many gaps in the story, an in-depth analysis is needed to better understand the contribution of the program.

KEY REFERENCES

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OVERVIEW OF IMPACT ASSESSMENT METHODS

Introduction

Historically several methods have been used to study the impact of R&D programs. This chapter summarise the various techniques used by different authors (see Table 22.1).

Modified Peer Review

Traditional peer review involves the assessment of the quality (scientific merit) of the research by scientific experts (peers) in the specific research field. Modified peer review on the other hand involves combining some form of socio-economic impact assessment with traditional peer review. This is accomplished by including non-peer members in the expert group such as economists, social scientists, civil servants, extension staff, NGO representatives, farmer representatives, etc.

The most common structure of a modified peer review involving scientific peers and socio-economic experts is that the two reviews are carried out independently and the results are then brought together in an integrated report by a third party. Sometimes, however, the assessments of the scientific peers are provided to socio-economic experts, who then take these options into consideration in carrying out their own review.

Modified peer reviews often take the form of a basic question and answer format - facilitated by interview techniques. The method can also involve iterative discussion process to reach a consensus.

Weakness of Modified Peer Review

The major weakness of modified peer review is that generally a small number of individuals are involved, and, as a result, it is difficult to gather a sufficiently broad base of knowledge to credibly comment on the economic and social impacts of the R&D activities.

Suitability of Modified Peer Review

This method is equally well suited for assessing R&D carried out in the past, on-going R&D, and R&D that are being considered for the future. The method can be used for basic, strategic as well as applied R&D activities. It is most useful for assessing R&D projects and programs and not particularly useful for assessing larger R&D activities, i.e., national level allocation of resources within agriculture.

User Surveys

The most common method for assessing the economic and social benefits of R&D involves the use of surveys of the primary intended users of the research results. There are two basic types of such surveys:

- Client Surveys: Surveys in which the respondents are involved with the research organisations in research collaboration or some other form of active interaction; and
- Beneficiary Surveys: Surveys in which beneficiaries are selected to be a representative sample of the broader group of primary intended users of the research results.

These surveys are sometimes structured in such a way that the direct clients are a certain percentage of the total sample of primary intended users.

At times, it is necessary to use experts rather than users to review some of the research activities. This may be the case in situations where the primary intended users are not sufficiently familiar with the research to be able to answer questions.

Advantages of User Surveys

User surveys provide a more systematic review by using standardised interviews and questionnaires and gathering the views of a wider number of people, thereby overcoming the restrictions involved in using a modified peer review procedure with a limited number of participants. Quantitative indices can be formed if the questions are amenable to scoring, thereby providing concurrent method of making comparisons among R&D projects.

Disadvantages of User Surveys

The major disadvantage to user surveys is the problem of "grateful testimony," i.e., the possibility that the clients and users may be more positive about the relevance and usefulness of the R&D than is warranted. In addition, often there is difficulty in interpreting the results.

Handling "Grateful Testimony"

There are several way to handle the problem of "grateful testimony" when implementing user surveys. Several of these are:

- Pose a large number of questions of different types, all dealing with different aspects of client relevance and usefulness. These questions could be related to the interest of the client in the research area, indicators of the value of the R&D to the organisation and the indicators of the importance of the R&D to the clients organisation;
- Gathering more specific information on associated benefits is to ask the (potential) clients or users to describe, in very specific terms, the details of the use (or potential use) of the R&D and its related social and economic benefits;
- Conduct follow-up interviews with a subset of the (potential) clients/users surveyed to test the veracity of their answers by probing for additional details which generally reveals how honest they have been; and
- Validity also can be assessed in ex-post and on-going reviews by comparing them with other primary and secondary data relating to the relevance and usefulness of the R&D activity.

Issues Addressed in User Surveys

Issues that need to be addressed in user surveys are:

- Which type of user survey to implement;
- How to identify the users;
- How to structure the survey sample;
- When to use experts instead of users;
- How to ensure the validity of the results; and
- How to interpret the results.

Other User Survey Issues

In developing questionnaires and interview guides, one has to be careful to standardise questions in a manner that facilitates analysis, but does not place undue constraints on the amount of information that can be obtained, thereby resulting in the collection of trivial information. The individuals involved in developing the interview guides or questionnaires must have a clear understanding of the nature of the R&D activity being assessed.

Suitability of User Surveys

User surveys are most useful for past R&D and on-going R&D. The method is useful for assessing the impacts associated with R&D activities near the applied and development end of the R&D spectrum. In most cases, user surveys are often combined with some other method.

Benefit - Cost Methods

The theoretical underpinning of these approaches is found in the economist's concepts of supply, demand, consumer surplus, alternative costs, and willingness to pay. This form of analysis seeks to assess private and public investments in R&D in terms of both the economic and social benefits generated for society by the investment as well as the economic and social costs incurred by society to execute the project. Benefit-cost analysis provides a strong theoretical framework for analysing the economic and social impacts of R&D activities. It is always carried out on a project-by-project basis, and it attempts to assess the project in terms of both the economic and social benefits generated for society, as well as the economic and social costs incurred by the society to execute the project. The net benefits of the projects are then calculated as follows:

$$\textit{Net Benefit} = \textit{Gross Benefit (economic, social)} - \textit{Costs (economic, social)}$$

There are several variants of cost benefit measures:

- Net present value;

- Benefit - cost ratio;
- Pay-back period; and
- Rate of return calculations.

All these essentially involve the same techniques.

Costs

There are three types of costs associated with R&D projects that should be included in the analysis:

- The cost of generating the research results;
- The cost of introducing and supplying the results to the end users; and
- The cost incurred by the end users to implement the results.

Each of these categories of costs needs to be identified and included into the analysis. Any additional cost to the society also needs to be included. In terms of the costs of the R&D activity, they are calculated as "opportunity" costs, which represents the value of the goods and services that society forgoes when resources are transferred from one occupation to another. It is assumed that under this methodology, that society's land, labour and capital resources are approximately fully employed. Hence, they can only be utilised on a new R&D project if they are withdrawn from their alternative areas of employment.

Benefits of R&D

The benefits which result from the new or improved product, processes or systems which result from the research, are valued at the price society is willing to pay for them. These benefits include:

- Those for which prices are paid;
- Benefits associated with increased educational and training opportunities;
- Reduced environmental damage; and
- Improvement in health and safety.

It is worth noting that in many cases it may not be possible to associate an explicit value with such benefits. Many of the research benefits are intangible and existing valuation techniques do not readily apply.

In ex-ante analysis, in addition to costs and benefits, the probabilities associated with the realisation of these costs and benefits must be determined. The time sequence of the relevant costs and benefits must also be determined. The (expected) value streams of annual costs and benefits must be discounted to their present value in order to estimate the net benefit of the project.

The calculations must be based on incremental benefits and costs, i.e., the difference between the "with" and "without" scenario (those costs and benefits, which would not have occurred in the absence of the R&D project). It is often very difficult to meet this requirement because many social and economic benefits result from a combination of complementary R&D investments, incurred over substantial period of time and it is often not possible to isolate the influence of a specific R&D project.

Benefit-cost analysis is technically demanding and time consuming. However, the main value of benefit-cost analysis in R&D impact assessment is that it offers a systematic framework for identifying the costs, benefits and wider implications of R&D.

Suitability of the benefit - cost method

Benefit-cost methods are much more appropriate for past research than for on-going or future research. The benefit-cost method is very useful for assessing applied research dealing with a product/process development. In the past, studies have focused on "big winners."

Benefit-cost methods can be used for *ex ante* analysis of R&D within those sectors where the connection between R&D and sectoral impacts are clearer and more direct, such as agriculture. In order to use it in on-going or future research, one must have:

- A good idea of the likely outcomes of R&D;
- Their probability of occurrence;
- When they will occur;
- Who and when they will be applied; and

- The market for products or processes developed.

Cost-Effectiveness Analysis

Cost-effectiveness analysis is a particular type of benefit-cost analysis in which the objective is to compare costs of two different means of generating the same information or end product. Basically, it is a simple approach that compares the technical efficiency and cost of alternative methods to accomplish a given task, exogenously defined as required. This approach is most useful when one is evaluating two systems which yield comparatively similar outputs. The basic steps in cost-effectiveness analysis are:

- Define the objectives that must be attained;
- Identify the alternative methods of achieving the objectives or obtaining the output;
- Determine the costs of these various alternatives; and
- Compare the costs and rank them.

Advantages of Cost-Effectiveness Analysis

The primary advantage of the cost-effectiveness method is that one does not need any benefit information.

Short-Comings of Cost-Effectiveness Analysis

The major shortcomings of the cost-effectiveness approach are:

- There is nothing to prove that any of the alternatives compared can yield benefits over and above costs. This is why cost-effectiveness analysis is only justifiable in situations where one system is certain to be undertaken in the absence of the other; and
- The products/outcomes of the alternatives must be virtually identical in terms of output if the magnitude of the cost saving is to be representative of the net social benefit. If one of the alternatives costs less, but produces a lower quality product and/or has a different impact, then the computation of benefits becomes much more complicated. Lower cost will create a positive social benefit, but the lower quality will yield a disbenefit, that is, the willingness to pay will decline.

Case Studies

Case studies are one of the most useful methods of examining the relationship between R&D and its associated economic and social impacts. Case studies involve a detailed and thorough analysis of particular R&D projects or programs, and seek to track and document the evolution of economic and social impacts associated with these activities. Case studies are generally conducted in conjunctions with other methods such as surveys and Benefit-cost methods.

Advantages of Case Studies

When case studies are carried out in sufficient number and in sufficient detail, they represent probably the best chance of fully identifying the relationship between R&D activities and the resulting economic and social impacts.

Problems with Case Studies

Since case studies relate to specific R&D projects or a specific sample of projects, it is difficult (generally impossible) to aggregate the "results" from a group of case studies or to generalise the results to larger R&D activities, such as R&D programs or major research efforts.

Suitability of Case Studies

Case studies are suitable to estimate the impact of past R&D activities, although they are more suitable for assessing applied research.

Partial Indicators of Impact

The partial indicators of impact method involve the collection of information (generally readily available) for a number of items, each of which provides some insight into the extent of the socio-economic impacts resulting from the R&D. Information may include:

- Program inputs;
- Program activities;

- Program outputs; or
- Program impacts itselves.

Once the information has been collected, it is organised and presented in a way that enables people who are reviewing the information to draw conclusions regarding the impacts of the program (and especially changes in the impacts over time). For example:

- Percentage of projects completed during the past year for which the technical goals were met (or exceeded);
- The number of products developed during the past five years that are being further developed or marketed by industry; and
- The percentage of projects completed within the past year for which it is highly likely that the results will be ultimately used by the industry (this one requires and external assessment).

Advantages of Partial Indicators of Impact

The major advantage of using the partial indicators of impact method is that the information required to specify the indicators is relatively easy to collect.

Disadvantages of Partial Indicators of Impact

The partial indicators of impact method only provide a very partial picture. While this can be useful for program monitoring purposes, it is generally not sufficient for demonstrating the impact of R&D, or even understanding what they have been.

Suitability of Partial Indicators of Impact

The partial indicators of impact method are the appropriate method for assessing past on-going and future R&D. It is heavily used in monitoring of on-going R&D projects and programs. The partial indicators of impact method are the best method for more fundamental R&D and for R&D oriented toward the development and maintenance of research infrastructures.

Integrated Partial Indicators/Weighted Multiple Criteria Analysis/Scoring Analysis

Conceptually, this method differs little from a checklist or partial indicators of impact. The difference between these methods lies in the fact that there is some sort of system for “adding up” the partial indicators and arriving at a “bottom line score” for each potential R&D project or project area under consideration. The most common approach is to evaluate each project with reference to a specific set of criteria/questions (partial indicators). Each criterion is then assigned a numerical weight, which enables the array of R&D projects, or projects under consideration to be ranked in order of priority, according to the sum of the numerical values assigned to the various criteria.

Advantages of Integrated Partial Indicators

The major advantages of integrated partial indicators are:

- It forces the decision makers to evaluate all the significant factors which have bearing on the “worth” of the R&D and to make conscious trade-off’s among multiple goals;
- It forces R&D decision makers to determine the criteria for assessing what makes for a good R&D investment; and
- It compels decision makers to rank R&D projects in terms of their relative importance.

Problems with Integrated partial Indicators

Two problems with the integrated partial indicators method are:

- Potential arbitrariness and subjectivity in assigning weights to the various criteria; and
- It is not well suited for ranking R&D projects in significantly diverse research areas.

Suitability of Integrated Partial Indicators

The integrated partial indicators method is more suited for assessing R&D under consideration for the future. The method works best for research toward the applied/development end of the scale. The integrated partial indicators method is better suited for comparing projects within categories rather than across categories.

Patent Analysis

The principle behind patent analysis is that the technological performance of an R&D activity can be assessed by counting the number of patented products, processes or systems which results from the activity.

Problems with Patent Analysis

The primary problems with patent analysis are:

- It is dangerous to assume that patents are the sole output of research;
- Patents do not arise uniquely from a particular R&D project, nor is it an indication of failure if the project does not lead to a patentable result;
- Firms have variable properties to patent and these may change over time; and
- From the point of view of assessing the social and economic impacts of R&D, patent analysis provides no indication of whether the patented item is in use, who the users are, or how large the user group may be.

Patent analysis can be used as a partial indicator, when combined with other methods.

Mathematical Programming

The mathematical programming method is similar to the integrated partial indicators approach in that weights are placed on a set of criteria. However the mathematical programming method provides a more powerful and sophisticated priority setting technique in that it relies on a mathematical optimisation of a multiple goal objective function, subject to resource constraints (available funding and human resources) to select a portfolio of research projects.

Advantage of Mathematical Programming

The mathematical programming method selects an “optimal” portfolio taking into account the various evaluation criteria and constraints imposed in the programming problem rather than simply ranking research areas.

Disadvantages of Mathematical Programming

Mathematical programming is not particularly useful for evaluating too diverse a set of R&D projects. If either the criteria for projects assessment or the constraints faced in executing the projects are not well-defined, then nonsensical solutions can result.

Econometric Methods

Econometric methods are based on the specification of functional relationships between ongoing industry output or productivity, and research and non-research inputs. On the basis of the functional relationships specified, statistical measures of social returns to expenditures on research can be estimated. The commonly used econometric approach is the production function approach.

Problems with Econometric Methods

Econometric methods are very demanding in terms of design, data, specification of behavioural relationship, and the specific functional form. In addition, there are no clear ways of knowing if the functional form is correct. However, the resulting estimates of the social rates of return are quite sensitive to the specification. This is also exacerbated by the fact that the selection of variables is somewhat subjective.

Applicability and Characteristics of Different Methods

Table 22.1 summarises a composite of comments on the time frame, type of R&D, and strengths and weaknesses of various R&D methods.

Quantitative and Qualitative Debate

For a considerable period, emphasis was placed on unbiased, precise estimates, thus quantitative analytical techniques were favoured for impact studies. It has been claimed that:

- Statistical controls are adequate substitutes for design controls; and
- Qualitative methods/measures do not provide adequate information for generalisation and causation.

During the last decade, these perceptions came under constant criticism and as a result the previously rejected qualitative analysis became equally important. There is a general consensus that:

- Both qualitative and quantitative methods do have a legitimate role to play in research evaluation;
- Even qualitative assessments can lead to generalisation and causation, i.e., by ruling out all possible alternative explanations; and
- Qualitative methods are as good as survey method or experimental methods in establishing generalisation and causation.

General Remarks on Impact Assessment Methods

Within economic theory, the benefits of R&D can be readily addressed within the theoretical framework of welfare economies. This framework (which is most typically applied in the form of a benefit - cost analysis) provides a consistent methodology for tracking, identifying, defining, measuring and comparing the costs borne by society, and the benefits received by society as a result of undertaking a given R&D activity. However, what works in theory can be quite difficult to apply in practice.

The forms of quantitative economic analysis which stem from this theoretical framework and have been developed to capture these benefits (such as cost-benefit analysis, rate of return analysis, scoring models) require a number of technical demands to be met at the outset before they can be rendered operational. Most assessment techniques require a statement of the objective of the program/project/activity – formulated in a way that is specific enough to allow it to be used as the basis of analysis. That is, it must be possible to identify a set of project results that are consistent with achieving the objective. In addition, most assessment techniques require an understanding of the probabilities associated with realising the project results and of the time period over which project results will be realised and the benefit flow will occur.

Unfortunately, the nature of much of R&D activity is such that it is not always possible to satisfy these technical requirements. In many cases it is difficult to predict at the outset of a research project what the final outcome might be or whether the R&D activity even has the potential to generate measurable benefits. As R&D becomes more applied and more focused, it is possible to develop a clearer understanding of how the results may have an impact on technology and organisational missions, the applications that may result, what the number of potential users for the particular application might be, and the extent of the potential social and economic benefits that may be derived from a certain application. Even in these instances, the probabilities that need to be associated with these estimates must be considered carefully. In addition, the relationship between a particular R&D project and the generation of social and economic benefits is rarely direct. Rather the benefits are derived from a combination of complementary R&D investments incurred over a substantial period of time. Hence, even if economic and social benefits are realised, it is extremely impossible to attribute them to a specific R&D activity.

Even if one can overcome many of these difficulties (to a certain extent), there is another general problem associated with the identification and measurement of the social and economic benefits of R&D, and this relates to the economic conceptualisation of the R&D innovation process. The majority of assessment techniques developed to-date have been built on the assumption that the R&D process could be represented as a linear model in which knowledge developed at one level of R&D moves forward in a straight line (with some lag) to more advanced R&D activities. However, with the exception of R&D in specific, focused areas, this paradigm has proven to be inadequate as a way of conceptualising the vast majority of R&D activities and, consequently, of identifying and measuring the related social and economic benefits.

Table 22.1: Applicability and Characteristics of Different Impact Assessment Methods

Methods	R&D Time Frame	R&D Type	Strengths	Weaknesses
Modified Peer Review	Past, on-going, and future	All	▪ Relatively easy to organise. ▪ Can provide valuable information on potential impacts. ▪ Probably the best method for basic/strategic R&D. ▪ Cost is low to medium.	▪ Relies on the opinions of a small number of people. ▪ Qualitative information only.
User Surveys	Past and On-going	Applied research and development	▪ Overcomes the problem of a small number of respondents. ▪ Possible to develop quantitative indices. ▪ Relative cost - medium.	▪ Structuring the survey and analysing the results can be tricky. ▪ Often requires considerable time to identify users, develop survey methodology, and analyse results.
Benefit – Cost Methods	Past (can be used for on-going and future R&D in certain circumstances)	Applied research and development	▪ Can provide reasonably defensible estimates of potential benefits. ▪ Provides a structure and a framework for assessing R&D projects which forces the right questions to be asked.	▪ Can be very time consuming and labour intensive. ▪ Results are critically dependent on assumptions which can be highly uncertain. ▪ Because of cost and time requirements, can only be used for a limited number of projects. ▪ Relative cost - high, data collection requirements are demanding.
Cost-Effectiveness Analysis	Future, Past (to a certain extent)	Applied research and development	▪ Simplest ▪ Does not require benefit information. ▪ Relative cost – medium	▪ Nothing to prove that any of the alternatives compared can yield benefits over and above costs. ▪ If one of the alternatives costs less, but produces a low quality product/has a different impact, then the assessment becomes more complicated.
Case Studies	Past	Applied research and development	▪ Can provide good illustrations of the relationship between R&D and its impacts ▪ .Probably the best method for basic/strategic R&D. ▪ Relative cost - medium.	▪ Generally there is no way to "add up" the results of a group of case studies to obtain a measure of the total impacts of the group. ▪ The results cannot be extrapolated to other R&D projects which are not in the group.
Partial Indicators	Past, on-going, and future	All	▪ The information required to specify the indicators is relatively easy to collect. ▪ Probably the best method for on-going monitoring. ▪ Relative cost - low.	▪ The individual indicators can generally only be "added up" on a judgemental basis, making overall impact assessment more difficult. ▪ Provides only a very partial picture of impacts.
Integrated Partial Indicators	Future	Applied research and development	▪ An easy but structured way to identify research priorities. ▪ Forces the decision makers to explicitly consider the key determinants of impacts. ▪ Relative cost - low.	▪ Totally relies on the judgement of (usually a few) individuals. ▪ Potential for bias in assigning weights to different criteria.
Mathematical Programming	Past, on-going and future	Applied research and development	▪ More powerful and sophisticated. ▪ Enables one to select "optimal" portfolio. ▪ Can handle simultaneous change in many variables.	▪ Demanding in terms of data requirements. ▪ Relative cost - high. ▪ Not particularly useful for evaluating too diverse a set of R&D projects. ▪ If either the criteria or constraints are not well defined, there is a risk of arriving at a nonsensical "optimal" solution.
Simulation Method	Past and future	Applied research and development	▪ Flexible. ▪ Can be used to estimate optimal level of research at national, commodity, or program level. ▪ Can estimate the effect of research on prices, income, employment, or other parameters. ▪ Can handle simultaneous change in many variables.	▪ To be useful, they must accurately reflect the relationship between technological advancement and economic development. ▪ Requires extensive amount of time to construct, validate and data to operate. ▪ Relative cost - medium to high.
Production Function Approach	Past	Applied research and development	▪ Offers a more rigorous analysis of the impact. ▪ Estimates marginal rates of return. ▪ Statistically isolates the effects of R&D from other complementary inputs and services.	▪ Uncertainty in projecting past rates of returns to future. ▪ Demanding in terms of data. ▪ Selection of suitable functional form. ▪ Serious econometric problems. ▪ Relative cost - high.

R&D types: Basic/strategic research, applied research, production process development

Source: Based on D. Williams, 1993.

A number of recent studies suggest that R&D (especially less applied R&D) may incorporate forward knowledge on diffusion links, lateral diffusion links (i.e., research in one field may have an impact on research in another), and/or backward diffusion links (i.e., development activities which may lead to modifications in innovation process that tend to exhibit significantly nonlinear characteristics and are often discontinuous. The diffusion time lag between activities on the R&D spectrum is not well understood and tends to vary across different R&D disciplines. Existing impact assessment models are severely constrained in their ability to account for the various diffusion links and the number, and types of paths along which the benefits associated with R&D may arise. A unified theoretical basis for the R&D/innovation process has yet to emerge, and this has contributed to a lack of advancement in the development of more appropriate and practical assessment models.

Despite these problems, a number of practical and credible impact assessment techniques are available to evaluators. They can at least provide guidance in qualitatively identifying potential benefits and, in many cases, can provide for reasonably accurate quantified estimates. Given the problems associated with determining the economic and social impacts of R&D activities, an evaluator must be careful to select an assessment technique (or a group of techniques) which is capable of addressing the purpose and specific objectives of the project under consideration. The technique should also have the potential to capture the widest array of potential benefits associated with that object. One has to remember that R&D activities are not readily compartmentalised into discrete and easily definable activities and there is no single assessment method which applies to a single category of activities in all instances. Therefore, the methods available for evaluating the impacts of R&D must frequently be adapted and combined to meet the specifics of particular R&D activity. It is important to note that these methods are rarely used on its own. In any given assessment the most common practice is for two or more of these methods to be used in combination.

KEY REFERENCES

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ECONOMIC SURPLUS APPROACHES TO ROR ESTIMATES

Introduction

One of the methods very often used in empirical estimation of ROR for research investments is the surplus approach. The surplus approach estimates the economic surplus generated due to technological change. The theoretical underpinnings of this approach are found in the economic concepts of supply, demand, alternative costs, willingness to pay, as well as applied welfare economics. There are several modifications of this approach based on the nature and the type of shift assumed. In this chapter the concepts of consumer surplus, producer surplus, and welfare gains are discussed. The different techniques used to estimate the ROR for R&D investment using the economic surplus approach are then discussed.

Consumer and Producer Surplus

Three basic postulates of applied welfare economics (Harberger, 1971) underlie this approach:

- That the competitive demand price for a given unit measures the value of that unit to the demander;
- That the competitive supply-price for a given unit measures the value of that unit to the supplier; and
- That when evaluating the net benefits or costs of a given action (project, program or policy) the costs and benefits accruing to each member of a relevant group (e.g., a nation) should be added without regard to the individual to whom they accrue.

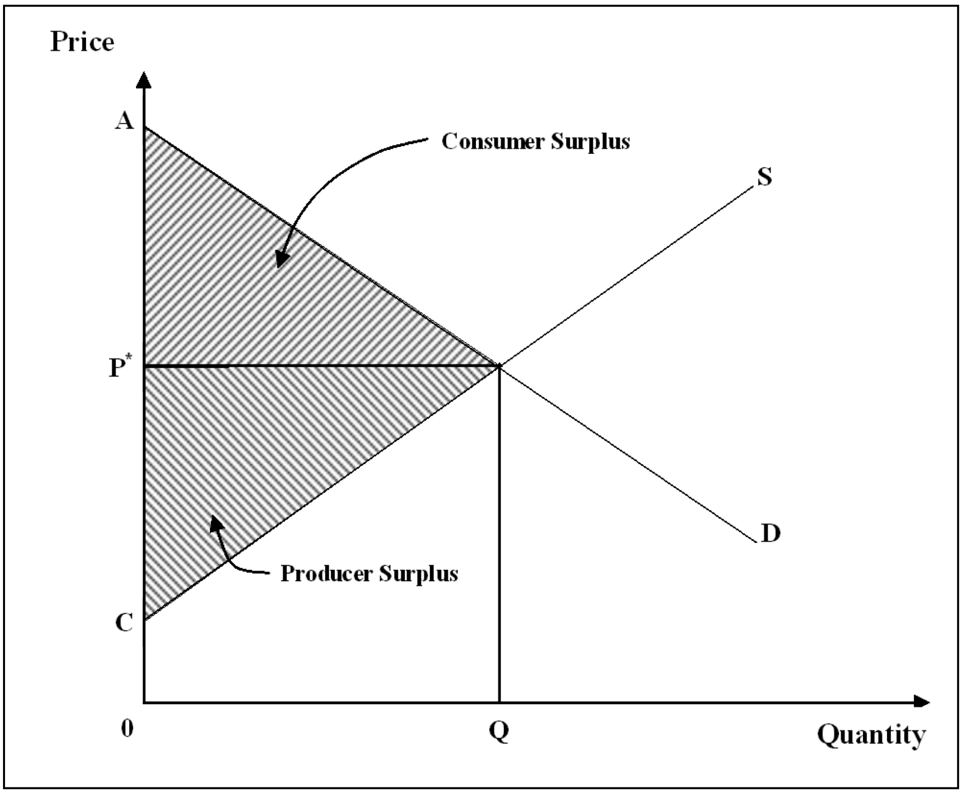
Consumer Surplus

Consumer surplus (CS) is defined as the excess of the amount a consumer is prepared to pay for a good over the amount the consumer actually does pay for it. Anywhere along the demand curve, the vertical distance indicates the amount the consumer is willing to pay for acquiring that quantity of the commodity. The difference between what the consumer is willing to pay and what the consumer actually paid represents the consumer surplus. This is the area ABP^* in Figure 23.1. Thus, the CS is the area under the demand curve and above equilibrium price level.

Producer Surplus

Producer surplus (PS) refers to the amount in excess of the actual supply cost. Anywhere along the supply curve, the vertical distance to the quantity axis represents the price at which the producer is willing to supply that quantity of the commodity. The difference between what the producer received and what he was willing to accept represents the producer surplus. This is the area represented by P^*BC in Figure 23.1. Thus, the PS is the area above the supply curve and below the equilibrium price line. The economic surplus is the sum of the producer surplus and the consumer surplus, i.e., the area ABC.

Figure 23.1: Producer and Consumer Surplus



Economic Surplus Changes Due to Technological Changes in a Closed Economy

Economic surplus at the original situation, i.e., with the old technology, is represented by:

$$P0 = \text{Equilibrium Price}$$

$$Q_0 = \text{Equilibrium Quantity}$$

$$BP_0C = \text{Producer Surplus} = (K + L)$$

$$P_0AB = \text{Consumer Surplus} = O$$

$$ACB = \text{Total Economic Surplus} = O + K + L$$

With the new technology, the supply curve shifts to S_1. Where the supply curve shift is parallel, i.e., the vertical distance between the two supply curves is constant, as shown in Figure 23.2. The impact of research is to reduce production costs, at the same time it also reduces the price received by the producers. The new equilibrium price and quantity are P_1 and Q_1 respectively. Now:

$$P_1FE = \text{New Producer Surplus} = L + M$$

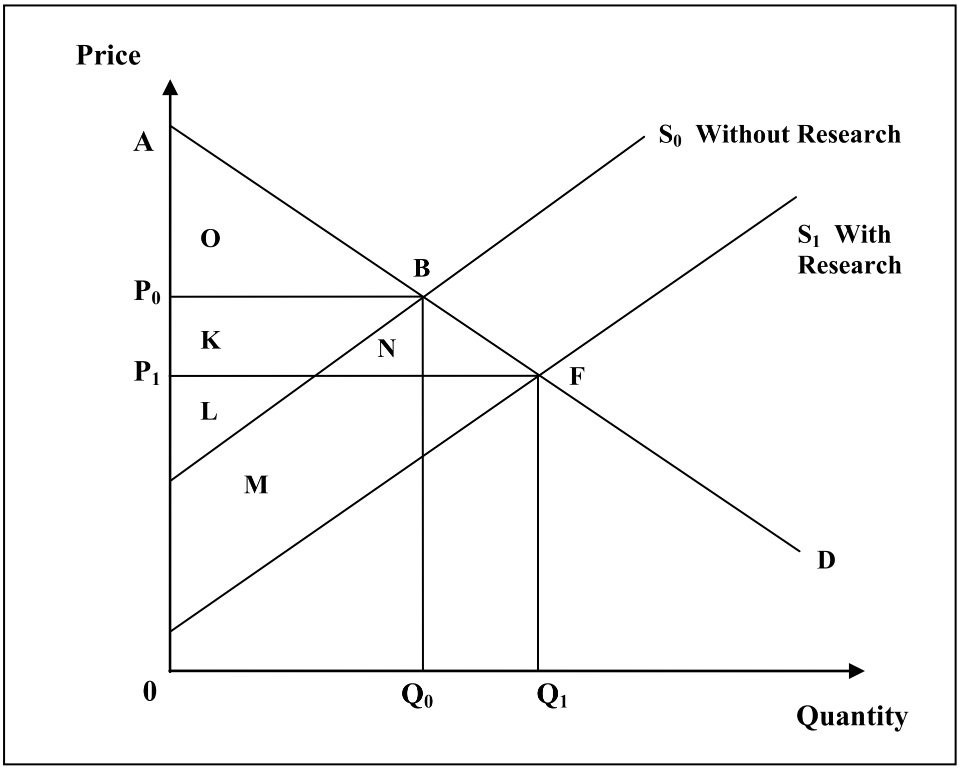
$$P_1FA = \text{New Consumer Surplus} = K + N + O$$

$$AFE = \text{The Total Economic Surplus}$$

The change in producer surplus due to research/ new technology is:

$$\begin{aligned} \text{Gain in Producer Surplus} &= FP_1E - BP_0C \\ &= (M + L) - (K + L) \\ &= (M - K) \\ \text{Gain in Consumer Surplus} &= P_1AF - P_0AB \\ &= (K + N + O) - O \\ &= (K + N) \end{aligned}$$

Figure 23.2: Producer and Consumer Surplus with New Technology



Note that the area K, which is lost by the producers as a result of lower prices, is a gain to the consumers. Net gain to the society is the sum of the net gain by the consumers plus the net gains of the producers. In other words:

$$\begin{aligned} \text{Net Gain to Society} &= (M - K) + (K + N) \\ &= M + N \\ &= \text{Area } CBFE \end{aligned}$$

Note: consumers will always gain from research as long as research output leads to a lowering of prices or an improvement in the quality of the product. Any change in economic surplus is a measure of the social benefit derived from research.

Empirical information needed to estimate the change in economic surplus includes:

- Knowledge of how much the technical change shifted the supply curve;
- Knowledge of the parameters that describe the conditions of demand and supply for the product; and
- The information on the costs of the research program required to induce a shift in the supply curve is also required.

Surplus Approach

The surplus approach estimates the economic surplus generated due to a technological change. Potential changes that occur from an improved technology are indicated by:

- A shift in the supply curve to the right;
- Consumers benefiting because more product is available at a lower price; and
- Producers benefiting because it costs less to produce the same amount.

As explained in the previous section, the concept of producer and consumer surplus can be used to measure these gains. Examination of the impact of production technologies comprises four main considerations:

- Comparison of direct costs and returns of alternative production practices;
- The cost adjustment from one production system to another;
- The output response of producers; and
- The overall costs and benefits from an industry-wide level of technology adoption.

Advantages of the Surplus Approach

The primary advantages of the surplus approach are:

- The surplus approach is flexible;
- It provides a mechanism to analyse how the benefits of research are divided between consumers and producers. This distributive aspect is more important if policy makers should have a particular goal to improve the welfare of either producer or consumer;
- The model may be applied to a closed economy or an economy open to trade; and
- It can handle side effects of technological changes such as income distribution consequences and environmental consequences.

Therefore, assessing the economic potential requires the use of modelling approach which considers both farm and market components. The farm level models establish the output and revenue changes resulting from the technology, given farm constraints and producer objectives. A gross margin analysis or a farm programming method could be used for this. Industry supply can then be estimated by aggregating the farm responses under an assumed level of technology adoption across the industry. This could be accomplished through:

- An economic surplus approach; or
- A market simulation approach which simulates the impacts of the new technology on the relevant market variables using a structural economic model, i.e., a system of equations which solves simultaneously.

Several approaches to estimate ROR have been developed using this theoretical framework. The methods are generally described as "index number methods."

Index Number Methods

The index number method attributes the downward shifts in the supply function of the enterprise to the new technology emanating from research, and measures the resulting social surplus as the gains to society. This approach involves:

- Specifying the supply and demand functions, which requires estimates of elasticities often obtained from previous studies;
- Estimating productivity indexes to measure the shifts in the supply schedule; and
- Developing a formula that measures the change in social surplus generated by increases in productivity. This formula is often simplified for empirical estimation.

The changes in social surplus are gross benefits attributable to research. To obtain net benefits, research expenditures are subtracted from the calculated gross benefits. The ARR is then calculated as the discount rate that makes the present value of the net benefit stream equal to zero.

It is important to keep in mind:

- The magnitude of distribution of change in economic surplus is sensitive to the nature of the supply shift;

- The distribution, but not the magnitude of, the change in economic surplus methods is sensitive to the nature of supply and demand curves (elasticities).
- Small farmers are both producers and consumers.

There are several modifications of the index number methods used in empirical analysis. These include:

- Benefit - cost approach using "with" and "without" scenarios. This is a special case of the index number method.
- Index number approach assuming linear demand and supply functions with parallel shifts in the supply function.
- Index number approach with linear functions and nonparallel shifts.
- Index number method with nonlinear functions with parallel shifts.
- Index number method with nonlinear functions and nonparallel shifts.

The most commonly used approaches are:

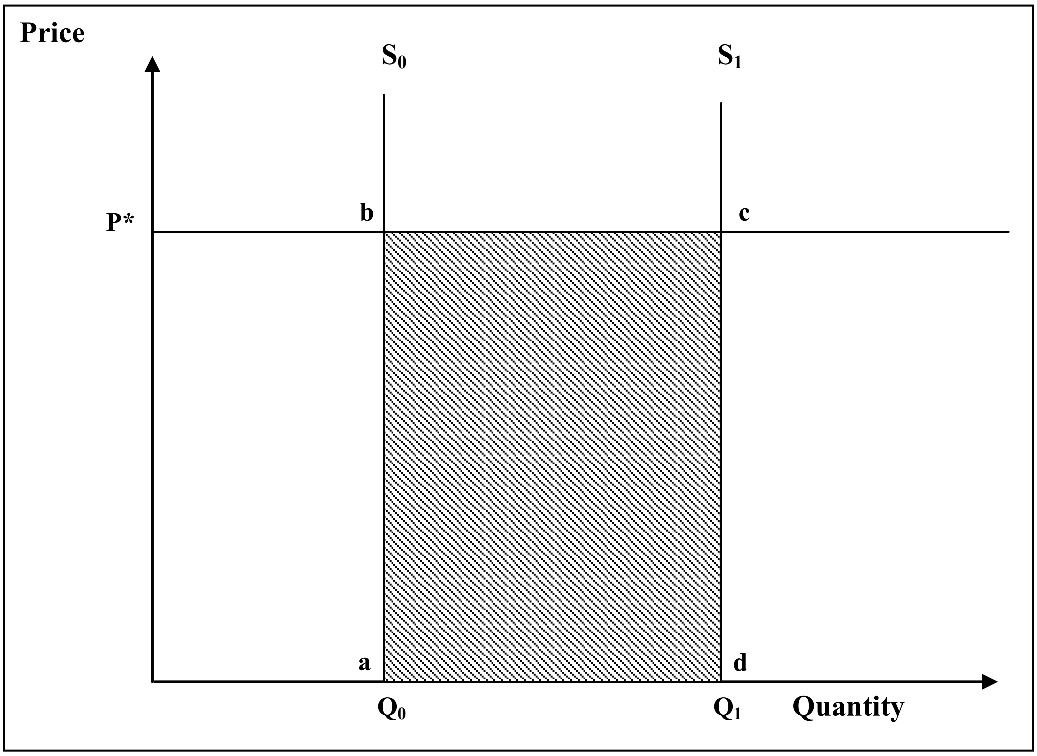
- Benefit - cost approach using "with" and "without" scenarios.
- Linear functions with parallel shifts.
- Nonlinear functions with parallel shifts (Akino & Hayami approach).

These three approaches are discussed in detail in the following sections.

The Benefit - Cost Analysis Approach

This is a simplified version of the surplus approach or Index Number method. A simple benefit-cost analysis case, as illustrated in Figure 23.3, has a perfectly elastic demand curve and a perfectly inelastic supply curve.

Figure 23.3: Perfectly Inelastic Supply and Demand Curves



The shaded area abcd is the increase in surplus. Note the entire benefit in this case will go to the producers. The welfare gain could be easily estimated by multiplying the differences in output (Q_1 - Q_0) caused by R&D investments, by the constant price P^*. Information on elasticities is not required to estimate the net benefit. If the shapes of the supply and demand curves are different, then the measurement of the area representing net benefits would require more complex formulations involving elasticity estimates. The main feature of a benefit-cost analysis framework is the specification of the "with" and "without" scenario.

"With" and "Without" scenario

Figure 23.4: Benefits Before and After Agricultural Research

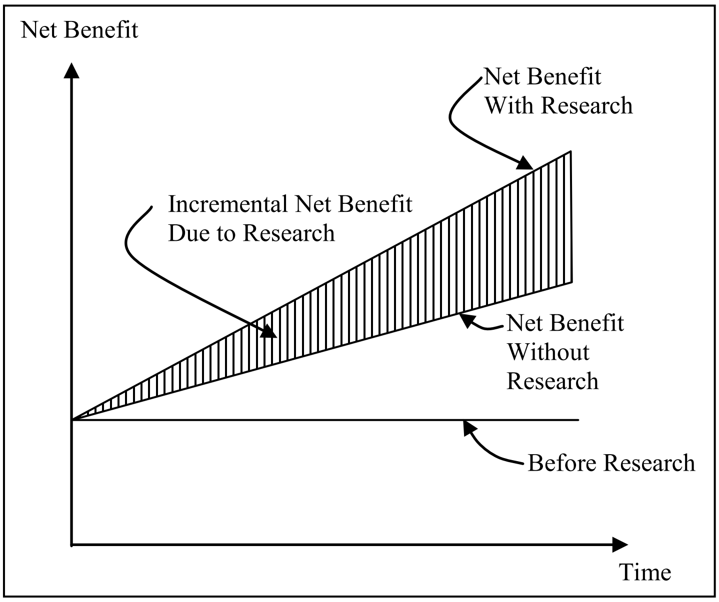
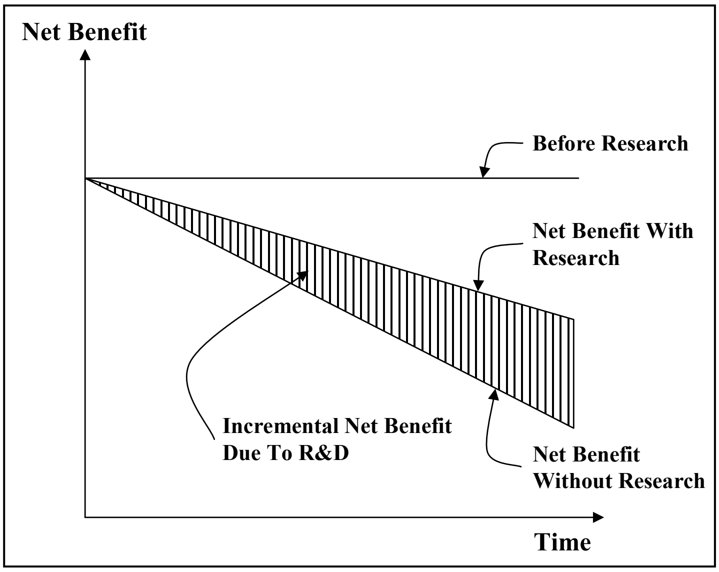


Figure 23.5: Benefits before and after Natural Resources Research



A typical "with" and "without" scenario is represented in Figure 23.4. The "with" R&D case corresponds to what has been observed over the years by adopting the new technology. The "without" scenario represent the situation in case if there was no research or the technological development. It is assumed that even without research (technology) some changes would have occurred in the level of production.

Therefore, the shaded area in fact represents the incremental net benefit due to research. This should not be confused with before and after comparisons. The before and after comparison is also known as historical comparison which reflects changes due to a large number of factors, including technological change. Using the "before" research situation would grossly overestimate the benefits as shown in Figure 23.4. Thus, impact assessment must be based on carefully constructed scenarios of situations "with" and "without" research. The "without" R&D case is most difficult to construct.

If we are dealing with natural resources, then one might observe a different situation as shown in Figure 23.5. For any technology, we are interested in estimating the incremental net benefit only. Therefore defining the "with" and "without" scenario is essential. Assuming the improved technology is an improved variety, one could estimate the net benefit of research in the following way.

Benefits

The benefits of the improved technology can be estimated as follows:

- Without Research:
  - Area in local varieties — A
  - Yield of local varieties — Y_0
  - Total Production with local variety — AY_0
  - Price of local variety — P_0

$$\textit{Value of Production} \quad M = AY_0 P_0$$

- With Research:
  - Area in local varieties — A_{01}
  - Yield of local variety — Y_0
  - Total production with local variety — $A_{01}Y_0$
  - Price of local variety — P_0

$$\textit{Production Value of Local Variety} \quad B = A_{01} Y_0 P_0$$

  - Area under improved variety — A_1
  - Yield of improved variety — Y_1
  - Total production with Improved variety — A_1Y_1
  - Price of Improved variety — P_0

$$\textit{Production Value With Improved Variety} \quad C = A_1 Y_1 P_0$$

(It is assumed the price of the product remains the same.)

$$\textit{Additional Benefit Due to the New Variety} = (B + C) - M$$

Costs

The costs associated with the improved variety can be estimated as follows:

- "Without" Research
  - Production cost — D
- "With" Research
  - Production cost — E
  - Research cost — F
  - Other costs (include seed production, marketing, extension, etc.) — G

$$\textit{Additional Cost} = (E + F + G) - D$$

$$\textit{Net Benefit} = \left[\frac{\textit{Additional Benefit}}{(B + C) - M}\right] - \left[\frac{\textit{Additional Cost}}{(E + F + G) - D}\right]$$

Commodity Research and Transfer Costs

Adoption Costs

There are four main components to include in adoption costs. These are:

- Difference in the cost of seed between new and old varieties;
- Difference in the costs of chemicals between new and old pest and disease control methods;
- Difference in the use of labour and equipment between the new and old production practice; and

- Differences in fertiliser use between the new and old varieties.

Research (Technology Development) Costs

Research and development costs include:

- Staff salaries and benefits;
- Recurrent expenditures;
- Overhead and administration expenditures; and
- Depreciation of capital assets.

Technology Transfer (Extension) Costs

Technology transfer costs include:

- On-farm research and demonstration trials;
- Costs of running the Commodity Training Center;
- Expenditures by the public extension institution on extension activities on a particular commodity (estimates);
- Expenditures by chemical and other input companies on extension and promotion activities;
- Expenditures by public and private product marketing firms on extension; and
- Expenditures by farmer organisations (commodity associations and farmers unions) on extension.

Calculating internal rate of return

The incremental net benefit flow is calculated by subtracting the research and transfer and adoption costs from the net benefits. The incremental net benefit flows over the years are converted into values that can be compared by discounting/compounding. This allows the taking into account of the time value of money. The discounted incremental net benefits can be represented as:

$$DINB_t = \left(NB_t - \sum_{j=1}^{M} RD_{jt} - \sum_{i=1}^{K} AC_{it} \right) r_t$$

where:

$$r_t = \frac{1}{(1+r)^t}$$

$DINB_t$ = *Discounted Incremental Net Benefits in Year t*

NB_t = *Undiscounted Net Benefits in Year t*

RD_{jt} = *The j^{th} R & D Expenditure in Year t*

AC_{it} = *The i^{th} Adoption Cost in Year t*

r = *Discount Rate*

There are M R&D expenditures involved in the calculation depending on the cost items included. In most cases, $M = 2$ representing research and extension expenditures. The research expenditures are lagged by a period long enough for the program to produce an impact at the farm level. The impact of longer and shorter lag lengths could be examined through sensitivity analysis.

The discount rate used is an approximation of the social time preference rate. This is normally taken as the real rate of interest on long term government bonds.

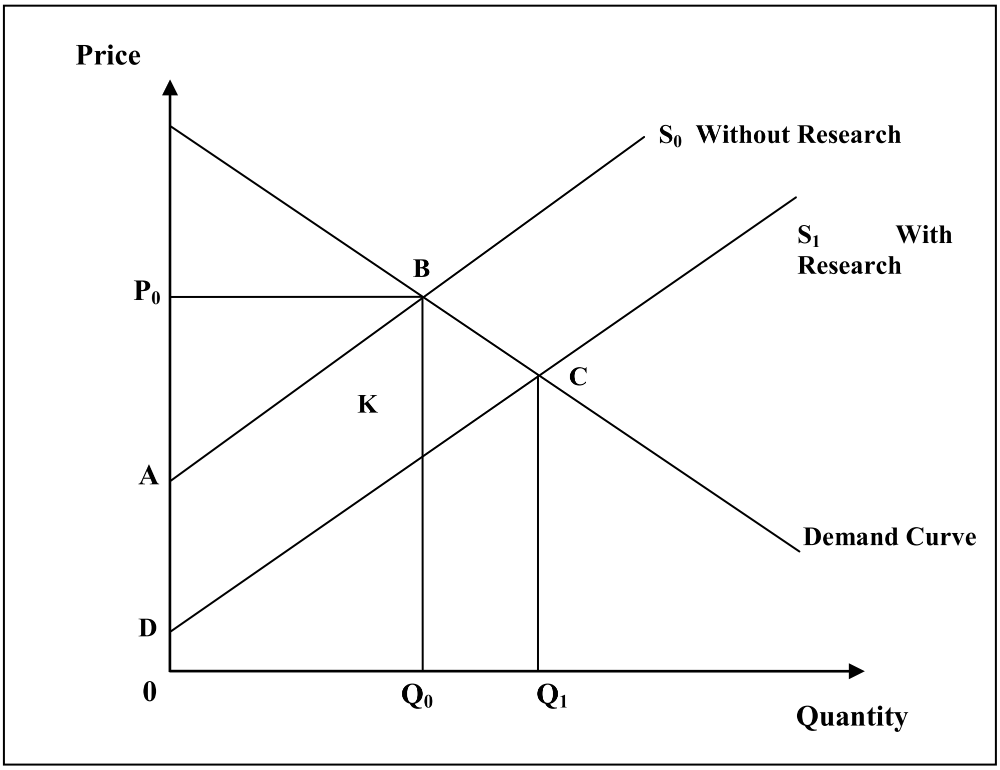
The summation of the discounted incremental net benefits yields the net present value (NPV) which indicated positive benefit, when the value is greater than zero. Of much interest is that discount rate that reduces the sum of the discounted incremental net benefits to zero. This discount rate is the internal rate of return (ROR). When this rate is greater than the social time preference rate then past investments on that particular R&D activity have been socially profitable.

Index Number Approach

Case 1: Linear Supply and Demand Curves with a Parallel Supply Shift

Demand and supply curves are linear and the supply shift is parallel as shown in Figure 23.6.

Figure 23.6: Linear Demand and Supply Curves, With and Without Research



Hertford and Schmitz (1977) provided the following formula to estimate the social surplus due to technological changes:

- Change in total net social surplus: $= KP_1Q_1\left(1+\frac{1}{2}\frac{K}{n+e}\right)$
- Change in consumer surplus: $= \frac{KP_1Q_1}{n+e}\left(1-\frac{1}{2}\frac{Kn}{n+e}\right)$
- Change in producer surplus: $KP_1Q_1\left\{1-\frac{1}{n+e}\left[1-\frac{1}{2}K\left(\frac{2n+e}{n+e}\right)\right]\right\}$

Where:

K = Horizontal distance between S_0 and S_1
n = Absolute value of the demand elasticity
e = Absolute value of the supply elasticity

In empirical studies, the procedure in section 23.6.2 is used in estimating the social gains from research. For a detailed discussion of the underlying assumptions and derivation of the formulas used in the calculation, the reader is referred to *The Economic Impact of Agricultural Research: A Practical Guide*[1].

1 For a detailed discussion of the underlying assumptions and derivation of the formulae used in the calculations, the reader is referred to W.A. Masters, et al. (1996), The Economic Impact of Agricultural Research: A Practical Guide.

Estimating the Social Gains from Research

Assuming linear demand and supply curves, social gains due to research are estimated by:

$$Area\ ABCD = KQ \pm \tfrac{1}{2} K\Delta Q$$

(Addition in ex-ante studies and subtraction in ex-post analysis)

Where:

K = The Vertical Distance Between The Supply Curves
Q = $0Q_0$
ΔQ = $0Q_1 - 0Q_0$

Q is directly observable, the variables that need to be estimated are ΔQ and K. In order to do this we need estimates of:

ΔY = Yield increase;
ΔC = Adoption Costs;
t = Adoption rate;
A = Total acreage planted to the crop;
Q_1 = Total production; and
Y = Q/A
= Overall average yield

In order to calculate K and ΔQ, one needs to estimate J (total yield increase) and I (total cost of adoption).

Estimating the J Parameter

Three kinds of observable data are needed to estimate J. These are:

- The yield increase (ΔY) caused by adopting the new technology expressed in physical terms/units, e.g., kilograms per hectare;
- The adoption rate (t) expressed as the proportion of total area under the new technology; and
- The total area (A) in the crop (often measured in hectares).

Then: $J = \Delta Y \times t \times A$

W.A. Masters et al. (1996) argue that it is more practical to compute the J parameter in proportional terms as the increase in quantity produced as a share of total quantity. In other words:

$$j = \frac{J}{Q}$$

Where: $j = \dfrac{(\Delta Y \times t)}{Y}$

Y *is the overall yield level :* $Y = \dfrac{Q}{A}$

Estimating the I Parameter - The Adoption Costs

The I parameter is defined as the increase in per unit input costs required to obtain a given production increase (J). In order to estimate I, the following information is needed:

- The adoption costs (ΔC) per unit of area that switched to the new technology;
- The adoption rate (t) in terms of area; and
- The overall average yield.

Then: $I = \Delta C \times \dfrac{t}{Y}$

Once again it has been argued by Masters et al. that it is convenient to do the calculations in proportional terms. This proportional cost increase (c) is:

$$c = \frac{I}{P} = \frac{(\Delta C \times t)}{\left(\frac{Y}{P}\right)}$$

Estimating the K Parameter in the Supply Function

The K parameter is defined as the net reduction in production costs induced by the new technology, combining the effects of increased productivity (J) and adoption costs (I). This is shown as:

$$K = J / (eQ / P) - I$$
$$= (JP / eQ) - I$$
$$\text{Where : } e \text{ is The Supply Elasticity}$$

Using the proportional term:

$$k = K / P$$
$$= (JP / eQP) - I / P$$
$$= (j / e) - c$$

Estimating the ΔQ Parameter

In proportion terms:

$$\Delta Q = Qnek/(n + e)$$
$$\text{Where : } n \text{ is the Elasticity of Demand expressed in absolute value}$$

For details, see Masters et al. (1996).

One could use the original formula to estimate the gains to the society. The gain to society is equal to:

$$KQ \pm 1/2\ K\Delta Q$$
$$\text{Where : } K \text{ is known;}$$
$$\Delta Q \text{ is known; and}$$
$$Q \text{ is also available}$$

In order to estimate the net gains, one will have to subtract the research and extension expenditures from the estimated gains:

$$\text{Net Gains to Society} = \text{Change in Surplus} - \text{Research and Extension Cost}$$

Social gains (SG) in each year:

$$SG = kPQ \pm 1/2kP\Delta$$
$$P = \text{The Producer price;}$$
$$Q = \text{Quantity produced;}$$
$$\Delta Q = \text{Change in equilibrium quantiy}$$

The second term is subtracted in an ex-post study, but added in an ex-ante study.

Net gains to the society:

$$\text{Net Gain} = \text{Social Gain} - (R + E)$$
$$\text{Net Gain} = kPQ \pm 1/2kP\Delta - (R + E)$$

Case II: Akino - Hayami Method

The Akino - Hayami model, Figure 23.7, assumes a constant elasticity of demand and supply and the supply shift due to technological change is considered to be pivotal. The original work was done by Akino - Hayami, where they attempted to measure the social return to rice breeding, measured in terms of changes in consumers' and producers' surplus resulting from the shift in the supply curve corresponding to a shift in the production function. Lines dd and S_0 represent the actual market demand and supply curves, whereas S_n represents the supply curve that would have existed if the improved (rice) varieties were not developed.

Figure 23.7: Akino-Hayami Method

- Increase in consumer surplus: = *Area ABC – Area* BP_nP_0C
- Increase in producer surplus: = *Area AC0 - Area BPnP0C*
- Social Benefit: = *Area ABC + Area AC0*

In this case the constant elasticity of demand and supply functions were assumed.

Demand - $q = Hp^{-n}$

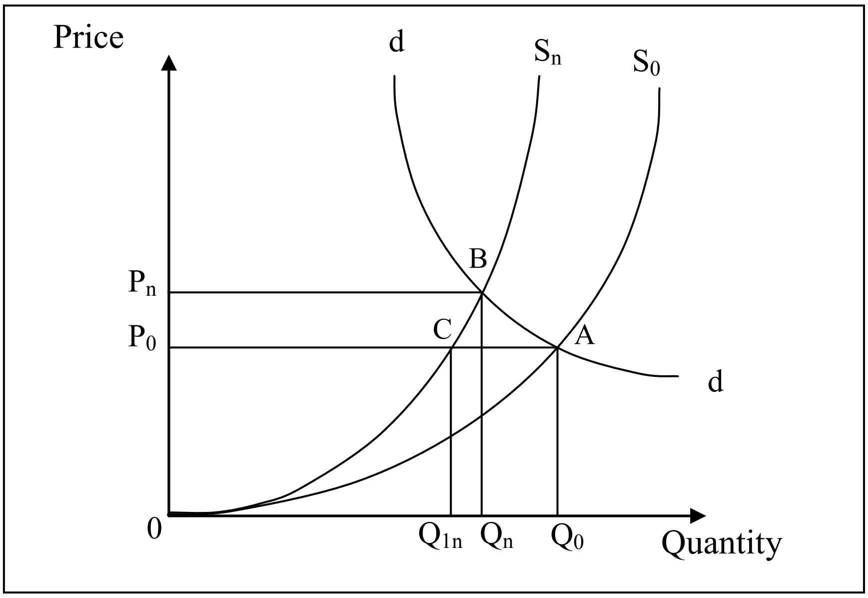
Where: *q and p are respectively the quantity and price*
n equals price elasticity of demand

Then:

Supply – $q = Gp^{e}$

Where: *e is the price elasticity of supply*

The hypothetical supply curve that would have existed in the absence of improved varieties is:



$q = (1 - h)\ Gp^{e}$

Where *h* is the rate of shift in the supply function due to varietal improvement.

In competitive equilibrium, the supply function is equivalent to the marginal cost function derived from the production function. Since the relation between the rate of shift in the marginal cost function (*h*) and the rate of shift in the production function (*k*) can be approximated by: $h \approx (1 + e)k$

Akino - Hayami established that the following approximation formulas hold at equilibrium:

$$Area \quad ABC \approx \tfrac{1}{2}\, p0q0 \;\frac{[k(1+e)]^2}{e+n}$$

$$Area \quad A0C \approx kp0q0$$

$$Area \quad BP_nP_0C \approx \frac{p_0q_0k \quad (1+e)}{e+n} \times \left[1 - \frac{\tfrac{1}{2}k(1+e)n}{e+n} - \tfrac{1}{2}k(1+e)\right]$$

and: $$Area \; ACQ_n^1Q0 \approx (1+e) \quad kp0q0$$

In order to estimate the social returns, one needs to specify:

- Price elasticities of demand and supply (n and e);
- Rate of shift in the production function (k);
- Value of the commodity output (p_0q_0); and
- We also need the research cost to calculate the social rates of returns.

The shift in the supply curve can be approximated by: $(1+ \; e \;) \; k$

Note: Although the relative magnitude of change in consumers' and producers' surpluses are critically dependent on the choice of specific values of demand and supply elasticities, the social benefit is not so sensitive to these parameters as *k* is the small fraction of the output.

Algebraic Model

This is the algebraic model used in carrying out an ex-post evaluation of the payoffs to hybrid maize research in Zimbabwe from 1932 to 1990.

- Demand equation: $Qt = \alpha_t P_t^{-n}$
- Supply equation without hybrids: $Q_{s_0 t} = \beta_t P^e_{0(t-1)}$
- Supply equation with hybrids: $Q_{s_1 t} = \beta_t (1 + K_t)\, P^e_{1(t-1)}$
- Without hybrid: $Q_{d_t} = Q_{s_0 t}$
- With hybrid: $Q_t = Q_{s_1 t}$

The above set of equations can be rearranged to give:

$$P_t = P_{1t} = P_{0t}\left(1 - \frac{K}{e+n}\right)$$

and: $$Q_t = Q_{1t} = Q_{0t}\left(1 + \frac{nK_t}{e+n}\right)$$

and: $$K_t = \frac{[\,Y_{1t} - Y_{0t}\,]}{Y_{1t}} \; \frac{[\,A_{1t}\,]}{A_t}$$

Where:

P_t = Farm level price of maize in year 1

Q_{dt} = Amount of maize consumer in year t

$Q_{s_0 t}$ = Amount of maize that would have been produced in year t

$Q_{s_1 t}$ = Amount of maize produced in year t with hybrids

K_t = The shift in the supply curve due to maize hybrids in year t

Y_{0t} = The average non – hybrid maize yield in year t

Y_{1t} = The average hybrid maize yield in year t

A_{1t} = The area planted to maize hybrid in year t

A_t = The total area planted to maize in year t

e = Price elasticity of maize supply

n = Absolute price elasticity of maize demand

α, β Represent all other omitted variables that effect the demand and supply functions, respectively

The shift factor K_t is a product of two parameters. The first parameter measures the yield change as the ratio of the yield differences (hybrid less non-hybrid) divided by the improved (hybrid yields). The second term is a measure of adoption with the area under maize hybrid being divided by total maize area.

These equations can be used to calculate the total research benefits (BN_t):

$$BN_t = K_t Q_{1t} P_{1t}\left[1 + \frac{(n+1)^2 K_t}{2(e+n)}\right]$$

Research benefits captured by consumers (CBN_t):

$$CBN_t = P_{1t} Q_{1t} K_t\left[1 - \frac{1}{2} K_t (1+e)\left[\frac{n}{e+n} - 1 + \frac{1+e}{e+n}\right]\right]$$

The benefits that accrue to producers in each year are obtained by subtracting the benefits to consumers (CBN_t) from the total research benefits (BN_t).

The total benefit is the sum of the areas A0C and ABC.

Area A0C is calculated as: $A0C = K - factor \times Total\ Production\ Value$

Where:

$$K\text{ - }factor = Proportion\ of\ area\ planted\ in\ improved\ varieties \times \frac{Yield\ gains\ from\ improved\ variety}{Improved\ yield\ of\ variety}$$

$$= Proportion\ of\ area\ planted\ in\ improved\ varieties \times \frac{Yield\ of\ improved\ variety - Yield\ of\ old\ variety}{Yield\ of\ improved\ variety}$$

Area ABC is calculated as:

$$ABC = .5\ x\ Area\ A0C + K - factor \times \frac{(1 + Price\ Elasticity\ of\ supply)^2}{Price\ Elasticity\ of\ supply + Price\ Elasticity\ of\ demand}$$

Costs of R&D and Extension

The cost of R&D includes three major items:

- Research and development costs;
- Adoption costs; and
- Research maintenance costs.

Research and Development Costs

These are costs associated with the development of the technology. They generally include:

- Cost of undertaking initial research including administration cost; and
- Cost of developing research results into a workable technology.

The research and development cost items in general include:

- Divisional expenditure:
  - Staff cost, i.e., salary and benefits;
  - Research maintenance and support;
  - Repairs and maintenance;
  - Equipment cost; and
  - Other capital expenditures;
- Institute/department overhead;
- Corporate overhead; and
- Building replacement, etc.

Adoption costs

Adoption costs include:

- The cost of applying the technology on the farm as incurred by the farmer;
- Extension cost including on-farm research costs.

Research maintenance costs

Research maintenance costs refer to any on-going R&D or extension needed to keep the new technology viable. For example, cost associated with retaining disease resistance of a variety.

Application of Akino-Hayami model to estimate rates of return

Once the benefits in the form of consumer and producer surplus have been calculated, the research and transfer cost will be subtracted to obtain the net benefit of investing in research. The net benefits are discounted to take into account the time value of money. The general form of the model is presented as follows:

$$DB = \sum_{t=1}^{T} r_t (BNt - Ct)$$

$$With: \; r_t = \frac{1}{(1+r)^t}$$

Where:

DB	=	*Summation of net benefits* BN_t
BN_t	=	*Summation of consumer and producer surpluses*
C_t	=	*The research and transfer costs over the years*
r	=	*Discount rate*
r_t	=	*Real discount rate or discount factor*

Calculating the rate of return involves solving for the internal rate of return, which is equal to the discount rate that reduces DB to zero.

Cost Saving Method

Rationale for the cost-saving method

A new technology can affect costs in various ways. For example:

- It could provide increased output for the same level of inputs (simply a yield increase);
- It could simply reduce the inputs (require less chemicals); or
- It could affect both outputs and inputs simultaneously.

Assume a new technology increases yield and/or reduces input. The implication of this is the lower fixed cost per unit output as well as the variable cost per unit assumption. Let us assume that with the old technology (without scenario):

- The per unit fixed cost is AFC_0
- The per unit variable cost is AVC_0
- The total cost per unit of output is

With the new technology (with scenario):

- The per unit fixed cost is AFC_1
- The per unit variable cost is AVC_1
- The total cost per unit of output is

The difference between the "with" and "without" ("before" and "after") average per unit cost is the reduction in the per unit cost "R." This "R" factor is used in the estimates of the rates of return.

$$\textit{Reduction in Per Unit Cost} = ATC_1 - ATC_0 = R$$

The magnitude of cost reduction depends on:

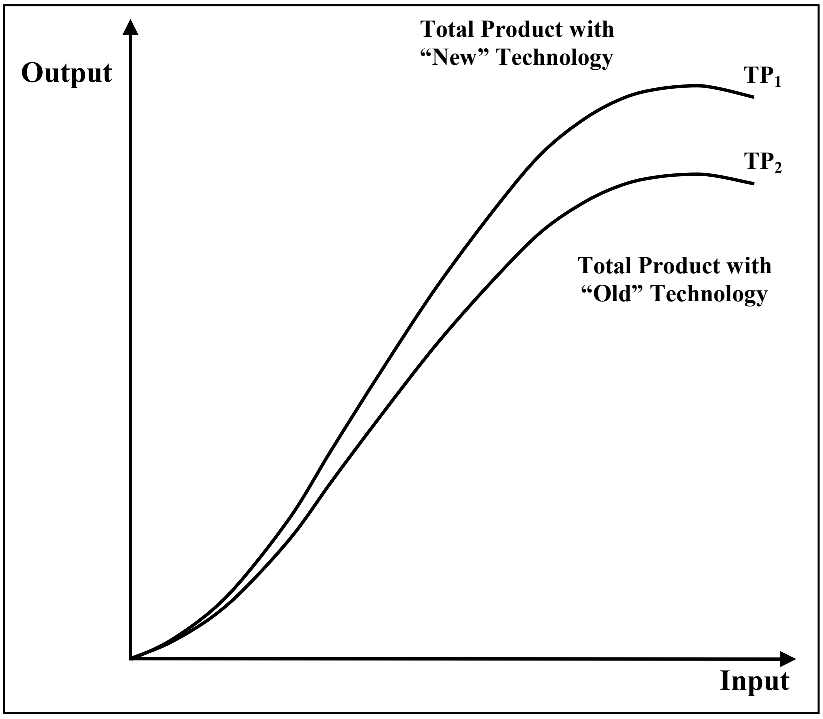
- Productivity of the technology; and
- Additional inputs needed.

One should remember that the total fixed cost will not vary, but the average fixed cost will vary depending on the level of output.

Theoretical Background

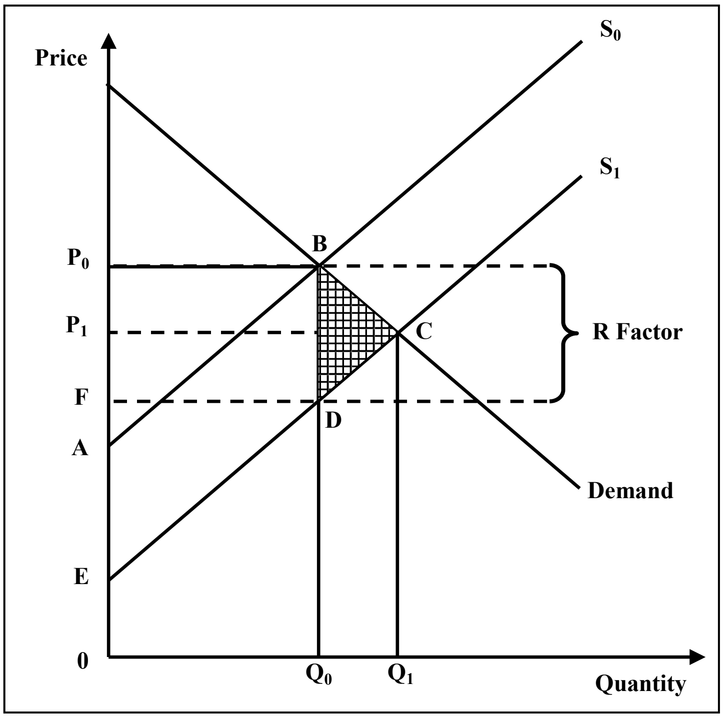
At the old technology T_0, the farm level response function was TP_0 (see Figure 23.8). The market demand curve is D_0 and the supply curve is S_0 (see Figure 23.9). The supply curve slopes upward as we assume that the good quality of land for production of the commodity "A" is scarce as it costs more per unit to produce as the industry output expands. $0P_0$ and $0Q_0$ are the initial industry (equilibrium) prices and quantities. Prices are the relevant prices at the farm gate level. The initial value of the output of the industry is $0P_0 \times 0Q_0$.

Figure 23.8: Effect of Technology at the Farm Level



Assume a new technology has been introduced. As a result, the farm-level response curve shifts upwards, assuming a yield increasing variety. The increase in the yield will lower the cost per unit, i.e., affect both the average variable cost as well as the average fixed cost.

Figure 23.9: Effect of Technology at the Market Level



The lower average cost is reflected in the shift of the supply curve from S_0 to S_1. This is assumed to apply equally to all output irrespective of whether small or large amounts of that commodity are produced. Hence, it is modelled as a parallel shift in the supply curve. At the new market clearing price $0P_1$, the producers have expanded output and have been able to do so at lower costs, and consumers are able to purchase more of the commodity also at a lower price. The lower producer cost and consumer prices are counted as welfare gains to the society.

The net gain in welfare to both producers and consumers is the area ABCE. In order to estimate the area ABCE, the slopes of the supply and demand curves need to be known. The area ABCE could be approximated by ABDE, but this ignores the additional triangle BCD. The net gain to the industry is the total savings in costs at the original level of industry output, i.e., the area ABDE. Similarly, net gains could be estimated by the area P_0BDF, which is the cost saving to the industry at the original level of output $0Q_0$. This is the simplest method for estimating total benefit and could be called the cost saving method.

One should note that using either area ABDF or P_0BDF avoids the need to use the elasticities of supply and demand, and is therefore, mathematically simpler to apply. As noted, this approximation could be expected to understate the benefits because although the area P_0BDF is equal to ABDE, it ignores the triangle BCD. In addition, the difference between the before and after per unit costs is the “R” factor used in the analysis.

Savings in Fixed Cost

The savings in fixed cost is more complex to estimate, and is often estimated indirectly by deduction. In a perfectly competitive industry (free entry, free exit, etc.) At long-run equilibrium:

Price = ATC
ATC = AFC + AVC
Price = AVC = AFC

Fixed cost per unit can be estimated by deducting variable costs per unit from the price received per unit.

An example of estimating fixed cost and cost saving

The following example could be used to estimate the cost savings due to a new technology. The gross margins for two varieties of maize are presented in Table 23.1.

Table 23.1: Gross Margin Budget Data for Maize

	Units	**"Without" The Old Variety**	**"With" The New Variety**
Yield	MT/Ha	13.3	15.0
Variable Cost	$/Ha	1323.3	1252.0
Average Variable Cost (TVC/Output)	$/MT	99.5	83.4
Price	$/MT	130.0	130.0

AFC for the new variety = Price - AVC = AFC = 130 - 83.4 = $ 46.6 per metric ton

Total fixed cost = AFC x Output = 44.6 x 15.0 = $ 699.0

The total fixed cost does not change with variety.

AFC for the old variety = TFC/Output = 699.0 / 13.3 = $ 52.5 per metric ton

ATC without the new variety = 99.5 + 52.5 = $ 152.0 per metric ton

ATC with the new variety = P = $ 130.0 per metric ton

∴ Cost savings per unit = 152.0 - 130.0 = $ 22.0 per metric ton

Methods for Estimating Cost-Savings

Examples of methods for estimating cost-savings are:

- A gross margin analysis can be used to estimate the cost-savings;
- ➢ Gross margin = gross income less variable costs;
- ➢ Savings in the variable cost per unit = variable cost per unit of output before the introduction of technology - variable cost per unit after the introduction of technology.

- If on-farm trial data or experimental data are used to estimate the benefit, there is a need to adjust the yield; and
- A partial budget could be used to estimate the ROR.

Assumptions in the Cost-Savings Method

Specific assumptions underlying this approach are:

- The technology resulted in a parallel shift of the industry supply curve. (Remember a parallel shift in the supply curve is not appropriate if the technology resulting from research is not applicable to all farmers or if the technology is not adopted by all farmers at the same rate.);
- Industries are competitive allowing fixed costs to be estimated as the difference between price per unit of output and the variable costs per unit of output;
- The change in welfare created by the shift in the supply curve is small relative to the pure cost saving effect at the initial level of output; and
- The external effects arising from the technology are small.

It is also important to note, that consistent with the model outlined earlier the appropriate level of output that should be used in the calculations is the level of output prevailing in the industry prior to the innovation becoming available. In order to estimate the ROR, one needs the diffusion information.

A further note. ROR can be estimated using farm-level experimental data. If experimental data are used, then there may be a need to adjust the yield. To estimate the impact, field prices should be used in the analysis. Another option is to use the enterprise budget, however, then there is no need to deduce AFC.

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PRODUCTION FUNCTION APPROACH

Introduction

The production function approach is the most commonly used econometric method to estimate the economic benefit of R&D. The production function is based on the idea that the amount of output of a production process depends upon the amounts of input(s) used in the process. Further output depends upon input in such a way that there is one unique amount of output resulting from each possible amount of input. For any production process this unique relationship between output and input is referred to as the production function for the process.

Definition of the Production Function Approach

A production function is the unique technological relationship between inputs and output, which represents the maximum amount of output producible from any set of inputs. It is cardinal in nature. Technology is assumed to be fixed and given. As long as technology remains constant, the production function remains unchanged and indicates the greatest output from a given input mix.

Production functions can be represented in various forms:

- Graphical form;
- Tabular form, i.e., as a table; and
- Mathematical functions.

A conventional general production function as a mathematical function could be expressed as follows:

$$Y = f\,(X_1, X_2 \ldots X_g, \overline{X}_{g+1} \ldots \overline{X}_k, X_{k+1} \ldots X_n\ )$$

This means the output, Y depends on (is a function of) a number of conventional inputs.:

$$X_1 \ldots X_g \rightarrow Variable\ Inputs$$

$$\overline{X}_{g+1} \ldots \overline{X}_k \rightarrow Fixed\ Inputs$$

$$X_{k+1} \ldots X_n \rightarrow Random\ Variables$$

Random variables are those variables that cannot be controlled in an actual production situation. Variable and fixed resources are of primary concern in production economics. In empirical studies, several forms of mathematical functions commonly used are linear functions, power functions, quadratic functions and cubic functions, etc.

The production function approach to impact assessment has been commonly used as an ex-post evaluation tool. The method specifies a production function for a commodity or agricultural sector and includes agricultural research and development (R&D) as a separate variable in the function to enable the calculation of marginal productivity of R&D, and consequently the marginal rates of return to investments in research.

The basic model takes the form: $Yi = \alpha + \beta X_i + \varepsilon_i$

Which expresses variable *Y* as a function of variable(s) *X*. *Y* is referred to as a dependent variable, *X* the independent variable(s), α the y-intercept, β the coefficient of regression, whose magnitude is the slope of the regression line represented by the equation, and ε the error term. The function can be linear or non linear. Regression analysis is used in estimations, predictions and causations. This approach estimates the contribution of each input to research by postulating a causal relationship between inputs (such as research, extension, prices etc.) as independent variables and output as the dependent variable. The coefficients of the independent variables, if found statistically significant are used to estimate the marginal productivity of these variables. The crucial element of the production function's approach is the way the lagged response of output to research inputs is specified in terms of length and pattern of persistence of benefits from the time they are first felt.

Griliches (1964) pioneered the use of the production function approach in evaluating agricultural research in the United States from 1949 to 1959. Using single-year lagged aggregate cross-sectional data, Griliches estimated the marginal rate of return of agricultural research and education of farm workers in the United States to be 35 - 40 percent. Later, Evenson (1967) used the same period, a mean lag length of six to seven years and a concave shaped distribution of benefits which generated a 47 percent rate of return to agricultural research. Attempts to use time-series data to calculate the payoffs to research have generally not been successful due to problems of data storage and high correlation of independent variables (Norton and Davis, 1981). To avoid these problems, duality approaches using profit and/or cost relationships have been used (Binswanger, 1974). This approach involves the aggregation of those variables that are likely to be interrelated.

Evenson & Flores (1978) have used the basic production function approach to deal with technology transfer problems. The basic model amounts to regressing the change in the yield of rice over a base period on a set of farm input variables that would be expected to influence yields plus a set of knowledge stock variables that are constructed as cumulative research investments. The knowledge stock variable includes:

- Research undertaken in agronomy and plant breeding specifically to improve rice technology;
- Research activity in plant physiology, phytopathology, and soil science (research which is not commodity specific);
- Agronomic and plant breeding research activities in countries other than the country in question, but which are in the same geo-climatic region; and
- Agriculturally related scientific research in other countries located in the same geo-climatic zone.

Since several variables are functionally related to *Y*, the latter is regressed on all the *X* variables simultaneously. This technique is called multiple regression, and is the basis of the production function estimation of factor productivity. Most regression lines are empirically fitted curves in which the functions simply represent the best mathematical fit (high goodness-of-fit measures in terms of R^2) to an observed data. Multiple-regression serves two purposes:

- To establish an equation that will enable better prediction of the dependent variable, *Y* than would be possible by any single independent variable, X_j; and
- To estimate and fit a structural model to “explain” variations in the observations of *Y* in terms of the independent variables X_j, in an attempt to answer the question of which explanatory variables affect the dependent variable significantly and appreciably, and what are the estimates of the relative magnitudes of the contributions on the independent variable.

Prediction of the impact of a variable

A multiple regression equation can be written as:

$$\hat{Y} = \alpha + \beta_{y1} X1 + \beta_{y2} X_2 \ldots + \beta_{yk} X_k$$

Where the estimate of the dependent variable, $\hat{Y}$, is a function of *k* independent variables, X_1, X_2........X_k. A coefficient such as β_{y1} denotes the regression coefficient of variable X_1 on *Y* that one would expect if all the other variables in a regression equation had been held constant at their means and is called a partial regression coefficient. This expresses the change of *Y* with respect to a change in that particular variable *X* expected when the rest of the variables are held constant.

Computation of the Rate of Returns to Research

Once the production function is estimated using regression techniques, a two steps procedure is followed to find the MRR to agricultural research.

Step 1

The value of marginal product of research is found by multiplying the research production coefficient by the average product of research. Thus, the MVP of research is:

$$MVPR = \beta_{Ry} \text{ times Average Product of Research}$$

$$= \beta_{Ry} \frac{Y}{X_R}$$

Step 2:

Step 2 involves determining the discount rate (MRR) which equals the discounted flow of these benefits with the discounted research costs. Thus, the discount rate (MRR) is:

$$MRR \text{ is } r \text{ when } \frac{MVP}{(l+r)^n} = 0$$

When rearranged it becomes:

$$r = (MVP)^{\frac{1}{n}} - 1$$

Where: *r* is the MRR.

A reasonable assumption on the value of n is that it is equal to the mean lag of the distribution of the benefits. Evenson (1967) estimated that research investment requires 6 - 7½ years before affecting production. In the case of agricultural technology, the lag period can be estimated empirically and is equal to the duration between commencement of research activity and the realisation of research benefit.

In empirical estimates, *Y* is often given in kilograms and (X_R) research expenditures are given in monetary terms.

$$\therefore \Delta R = \frac{\text{Mean Price} \times \Delta Y}{(1+r)^n}$$

$$r = \left(\frac{\text{Price} \times \Delta Y}{\Delta R}\right)^{1/n} - 1$$

where:

$$\text{Mean Price} = \text{Real average price for the sample period}$$

$$\Delta Y = \text{Change in output due to research}$$

$$\Delta R \text{ (or } \Delta X_R) = \text{Change in research expenditure}$$

Considerations in Production Function Approach

Choice of explanatory variables (predictors)

The desire is to predict the value of Y using as few predictor variables as possible while at the same time making the standard error as small as possible. However, these requirements are in conflict because increasing the number of variables will tend to explain more of the variation in Y and reduce the prediction error term. Yet a point of diminishing return is inevitable beyond which additional variables are able to explain proportionally less of the variation of Y. Thus, a good guide is to omit variables that do not make an appreciable contribution.

Should any relevant variables be omitted, the fitted model will be biased, only in an economic sense, it could not be expected to truly depict the production process either structurally or predictively. Likewise, the unwarranted inclusion of variables will also lead to bias. As much as possible, the variables omitted because of the limited research resources, should be those of limited importance. Often it requires a clear understanding of the mechanics of production and often compromises will have to be made from prior experiences and relative importance of the variable.

To some extent, the researcher may be able to use trial and error methods in deciding on the variables that are relevant. A given algebraic form of the production function may be tried with a variety of combinations of variables. The combination of variables which best account for the observed output may be selected. Two strategies can be pursued when selecting variables. One is to start with a single variable and then add variables one at a time until the addition of further variables does not produce an appreciable change in R^2. One criterion for the order in which to add variables is to add that which produces the largest increment in R^2, that is, by adding the variable with the largest partial correlation coefficient.

A second criterion involves computing F-values corresponding to tests of significance of the increment to R^2 due to the addition of a new variable. The variable that produces the highest value of F is selected first. Stop adding variables when the F-value becomes non-significant at some specified probability level.

The logical alternative to this mode of selection is to include initially all of the predictor variables in the regression equation and then drop those whose removal does not appreciably lower the determination of Y.

Choice of an algebraic form

In selecting the algebraic form, one should:

- Take into account the mechanics of the production process; and
- Consider that the selected function must be computationally manageable both for estimation and testing.

A number of empirical criteria are used in selecting the functional form. These are:

- Select different algebraic models and fit the observations to each of them. One of "best fit" then may be designed by the magnitude of the coefficients of variation R^2. The large value may be taken to indicate the form which is most appropriate for estimates;
- Using F-ratio and mean squares of deviation from regression. A larger F-ratio or a smaller mean square of deviations from regression is taken to indicate a model most appropriate for the particular set of experimental or sample observations; and
- Select initially a simple polynomial form and add terms one at a time, retaining those which account for a significant incremental portion of the variance in output.

However, for biologic and economic phenomena, it appears unlikely that a single mathematical form of production function is most appropriate for all environmental and resource situations. Some of the mathematical properties which we have learned about different production functions will give a guide line. (Two different individuals can give valid reasons for selecting two different functional forms.) These guidelines are:

- Compare predicted and observed yields over the relevant range of the production surface assuming all other criteria are satisfied, the best function will be the one for which the scattering of positive and negative residuals over the surface is random. A systematic tendency for the observed yield to exceed predicted yield, or (vice versa), over parts of the surface, it is an indication that the fitted function does not adequately characterise the observed data. Where there are three or more inputs involved, then this approach is messy; and

- Difficulties in estimating a continuous function could be eliminated by estimating points on the production surfaces. Because of uncertainty and imperfect knowledge, they would not be able to equate the slope of a continuous function with the price ratio even if the algebraic form were known with absolute certainty.

Disadvantages in the Production Function Approach

The production function approach is very data and time intensive and therefore has its utility where a sufficient amount of good quality data exists. The investigator is required to have a good understanding of statistics and econometrics. In addition, serious econometric problems often arise, i.e., serial correlation/auto correlation and multi-colinearity. Multi-colinearity arise when most of the variables of interest tend to move together over time and space, making it hard to untangle their separate effects. A partial correlation matrix between the independent variables can be used to identify whether multi-colinearity exist. Auto correlation arises when there exists correlation over time of the disturbance term in a single equation. The Durbin - Watson test is used to identify the existence of auto correlation.

If the DW statistics is close to 4, indicates the existence of negative auto correlation;

DW statistics is close to 0, indicates the existence of positive auto correlation;

DW statistics is close to 2, indicates no auto correlation.

The production function approach treats research, extension and other variables as exogenous variables in formulating the causal relationships.

Advantages of the Production Function Approach

The major advantage of the production function approach is that it statistically isolates the effect of R&D on productivity growth. One can study the effects of research, extension and even the first order interaction effects. The production function methodology has capacity to assess the impact of changes in funding levels, policy and institutional structures as well as the effects of complementary programs such as seed multiplication and distribution, extension and credit programs on R&D productivity. The approach is also useful in assisting priority setting and provides a guide to research resource allocation.

The various features of the four methods discussed in the previous sections are summarised in Table 24.1.

Table 24.1: Comparison of Different Methods of Estimation ROR

	Index Number Method *	Benefit - Cost Approach	Production Function Approach	Cost - Saving Method
• Accommodate Price Change	Yes	Yes	No	Yes
• Time Value	Yes	Yes	Yes	Yes
• Time Perspective (Ex-ante, Ex-post)	Both	Both	Ex-Post Only	Both
• Average/Marginal Rate	Average	Average	Marginal	Average
• Data Requirement	Medium	Medium?	High	Low
• Data Needed:				
➢ Elasticities	Essential	Assumed Away	No	No
➢ Research Cost	Yes	Yes	Yes	Yes
➢ Yield Response	Yes	Yes	Yes (Aggregate)	Yes
➢ Input Change (Adoption Cost)	Yes	Yes	Yes	Yes
➢ Prices	Yes	Yes	Yes	Yes
➢ Adoption Data	Yes	Yes	Yes?	Yes
➢ Extension Cost	Yes	Yes	Yes	Yes
• Distribution of Benefits	Yes	No	No	No
• Separating the Effects of Research vs. Complimentary Services	No	No	Yes	No
• Econometric Problems in Estimation	No	No	Yes	No
• Inclusion/Consideration of Externalities (tangible ones)	Yes	Yes?	No	Yes?

* Both Parallel and pivotal shifts ? Possible to include in the analysis.

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SPILL-OVERS AND IMPACT ASSESSMENT

Introduction

Analyses of research impacts are customarily done at the national level and often focus on the estimation of rate-of-return (ROR). However, at times, research findings may be potentially applicable to a range of agricultural production conditions or environments cutting across geographical and national boundaries. Simultaneously, the research process itself can induce changes in the organisational and management systems, available resources, etc., within the research services which may further contribute to the internal efficiency of the individual research systems. These additional potential benefits are often termed as “spill-over” effects.

In this chapter, the potential spill-overs of technologies and their implications to impact assessment are discussed. In addition, a simple framework for incorporating spill-over effects in ROR estimates is outlined. Spill-over benefits are real when there is research networking as is the case in SADC or ASARECA.

Types of Spill-Overs

The wide applicability of research results over a range of agricultural production conditions or environments often cutting across geographical and national boundaries are generally referred to as “spill-over effect.” Evenson (1987) identified four classes of spill-overs, namely inter-locational, inter-foci, inter-commodity, and inter-sectoral. These different types of spill-overs are discussed in the following sections.

Inter-locational spill-over

Inter-locational spill-over deals with the spill-over of technology from one location to another that is most important in regional commodity research networking programs. Locational spill-over will be greater between two locations with similar geo-climatic characteristics than between locations with dissimilar geo-climatic characteristics. According to Davis et al. (1987), spill-over effects from regions where research is conducted to other regions with similar agro-ecological and rural infrastructures ranged from 64 to 82 percent of the total inter-locational benefits depending on the commodity. Evenson also concluded that at least for the united States, the locational range of spill-in effects for crop production is lower than for livestock production.

Inter-foci spill-over

According to Evenson most agricultural research programs invest in the following specialisations:

- Pre-technology science (basic research);
- Technology invention and development (strategic and applied research); and
- Technology development and sub-invention.

The development or invention of technology is the primary objective of most research organisations. However, this technology development is dependent on the *science base* and the *technology base* that together define the invention potential of the research program. All organisations invest in pre-technology science programs to facilitate the development of invention potential.

The indirect locational research spill-over is defined to be channelled through invention potential. The pre-technology science research, e.g., gene transfer, in one country system has spill-over effects on its own country program as well as on other countries via enhancement of invention potential.

The technology developed in one country may also enhance the invention potential of another country even if the technology is not directly transferable to the other country. Germplasm in a breeding program is a good example of this type. However, these indirect spill-over benefits are tied to some geo-climatic inhibition that limits direct spill-overs.

Substations within a national program and some smaller NARS fit into this hierarchy in that they concentrate on adaptive development and sub-invention targeted to relatively small regions. They are typically technologically dependent on the main station or larger NARS and receive direct and indirect research spill-in from the main station or large NARS. According to Evenson, in the United States the chief inter-foci spill-over is between pre-technology and the applied invention oriented research.

Inter-commodity spill-over

The indirect spill-over mechanism will not be confined to a single commodity. ***Research on input-based technologies may be relevant to several commodities***. Pre-technology science findings may spill-over across commodities because they enhance the invention potential of several commodity technology programs. A technology to *control insects* or correct a *soil problem* will spill-over *across commodities*. A good example may be the control of *striga* and stalk borer in maize. These technologies can be directly applied to sorghum.

Inter-sectoral spill-over

Most private (and public) firms in an economy conduct two types of research programs. The first is directed toward *process improvements* in the sector itself (usually within the firm). This research does not spill-over to another sector except through price effects.

The second type of research is directed to *product improvement*. This research can give rise to *real and accounting* spill-overs, because when product quality changes, it is almost impossible to account for this quality change in terms of price. When a manufacturer introduces a new machine and sells it at a price that is 10 percent higher than the price of an existing machine, accounting methods will measure the new machine as providing 10 percent more real services. First, the manufacturer will have to provide some real discount to farmers to sell the machine (private firms in the United States claim that they only receive a third of the real value added from their inventions in the form of higher prices). Second, competition and expected competition from other manufacturers will also lead manufacturers to give a real discount to farmers. *These real discounts associated with the introduction of new products from the farm input supply sector, then constitute research spill-overs to the agricultural sector*. Post-harvest research, on the other hand, has a great deal of product improvement research, and this does have real non-price spill-over to consumers.

According to Davis et al. (1987), spill-over effect is a combination of four effects:

- Price effects from increased production caused by reduced costs which are captured in the supply and demand framework;
- Spill-over technology from country "Y" which can be adopted without any research in country "X";
- Spill-over of technology from country "Y" which requires adaptive research before it is applicable in country "X"; and
- Spill-over of scientific knowledge which ultimately enhances future research in many areas. This is sometimes called the spill-over effect of basic research which is difficult to quantify. Very often this is not estimated directly. However, past spill-over of this nature will be captured in the estimates of probability of success and possible level of adoption.

In most cases the research activities are single-commodity oriented. Therefore, we are primarily concerned with the inter-locational spill-overs only. However, depending on the technology being addressed, there may be limited inter-commodity and inter-sectoral spill-overs.

Spill-Overs Considered in Impact Assessment

Based on the above discussion, one could identify three major types of spill-overs, namely: economic spill-over, technological spill-over, and knowledge spill-over (Anandajayasekeram et al., 1995a). These three types of spill-overs are discussed in the following sections.

Economic spill-overs

Economic spill-overs refer to the price effects from increased production caused by reduced costs captured in the supply and demand framework. Within the global and regional context, these spill-overs will affect the inter- and intra-regional production, consumption, trade and prices. For example, a technology in one member state may induce an increase in the regional supply of a certain commodity such that its price will fall in other countries in the SADC region. This is illustrated below.

Case 1: Technological Change in Country A, But No Inter-Locational Spill-Over

Assume:

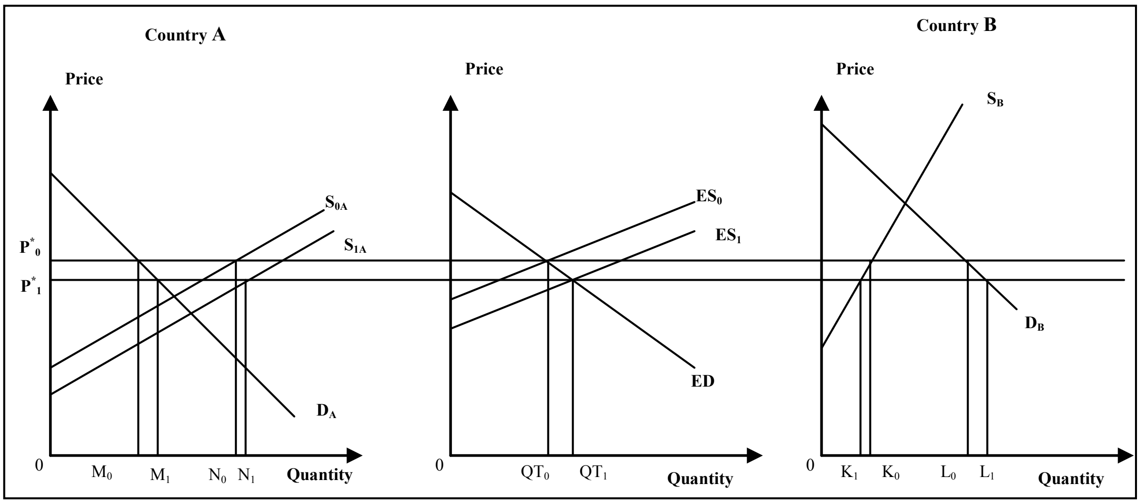
- Country A is a net exporter of commodity X;
- Country B is an importer of commodity X; and
- Trade is occurring between the two countries.

At equilibrium with the old technology (see Figure 25.1):

- Country A produces 0N and consumes 0M;
- Country B produces 0K and consumes 0L; and
- Quantity traded = $0QT_1$ = (0N - 0M) = (0L - 0K) = MN = KL

Let us assume a new technology is being developed and adopted by producers in country A only.

Figure 25.1: Spill-over Due to Technological Change



Implications:

- The supply curve in country A shifts to the right, to S_{1A};
- The excess supply curve also shifts, ES_1;
- The new equilibrium price will be lower, i.e., $P^*_1 < P^*_0$;
- Country A will produce $0N_1$ and consume $0M_1$;
- Country B will produce $0K_1$ ($0K_1$ < 0K) and consume $0L_1$ ($0L_1$ > 0L);
- Quantity Traded = $0QT_2$ = ($0N_1$ - $0M_1$) = ($0L_1$ - $0K_1$) = M_1N_1 = K_1L_1

Net Effects:

- Price goes down in both countries;
- Quantity traded increases;
- Quantity produced in Country A increases; and
- Quantity produced in Country B decreases.

Case 2: Technology Developed in Country A, But Was Adopted By Country B Also

In this case, the supply curve will shift to the right in both countries, but the shift in country B will be less assuming a positive adoption cost. If this is the case, then both excess demand and excess supply curves will shift.

In this case the new equilibrium price will be lower, but the quantity traded will be reduced compared with Case 1, because country B is also producing more as shown in Figure 25.2. In both cases the consumer in country B will benefit.

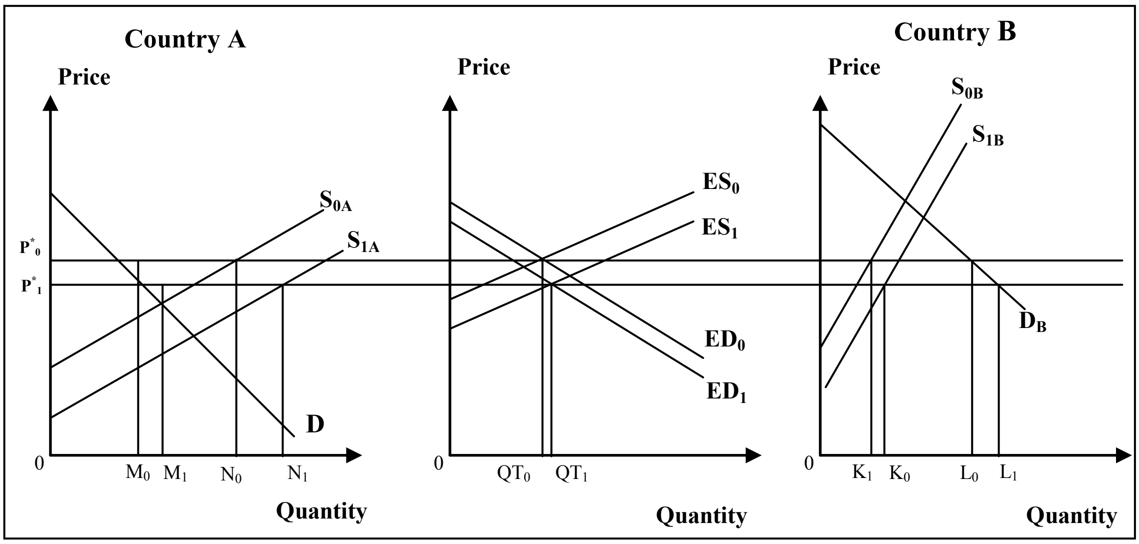


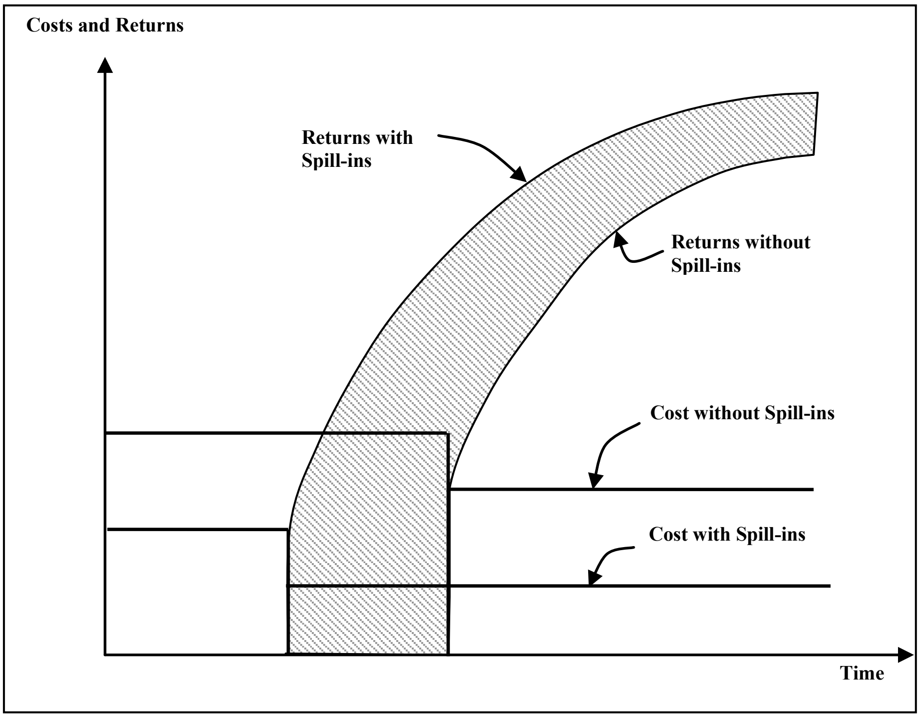
Figure 25.2: Technology Developed in Country A and also Adopted in Country B

Technological spill-overs

Technological spill-overs refer to the spill-over of technology from one country to another or from one environment to another. It is becoming common to refer to the extensive applicability of research across national and geographical boundaries as "spill-over" effects. Spill-over of technology can occur with or without adaptive research in the recipient country. Technological spill-overs increase the returns to research and can be "spill-ins" or "spill-outs."

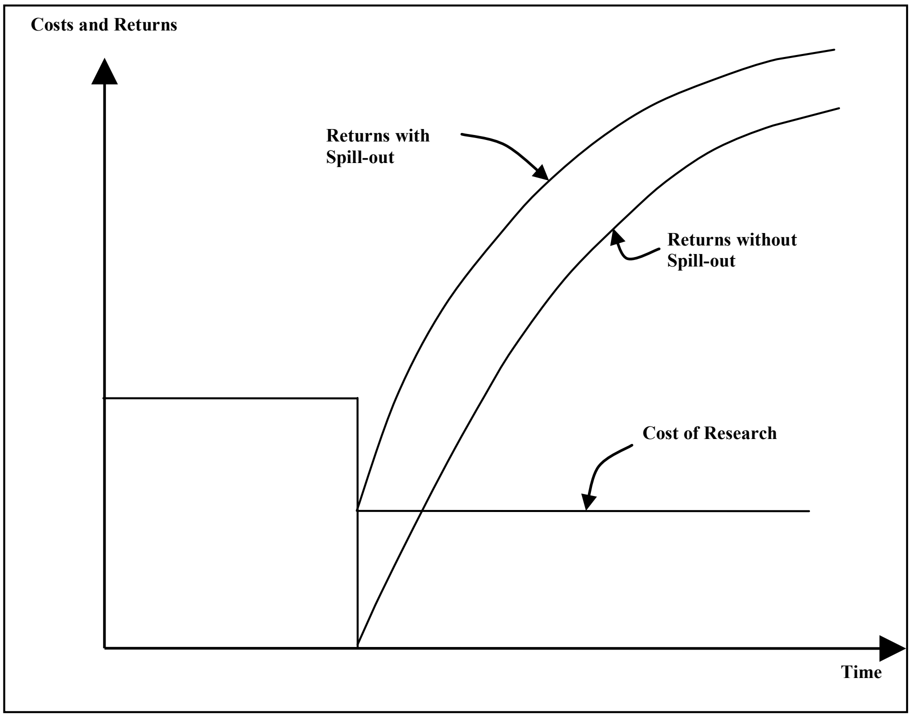
Spill-Ins: Spill-ins refer to a situation where a country is adopting a technology developed elsewhere. This reduces the national research costs as well as shortens the time required for technology development as shown in Figure 25.3. This aspect is critical at the planning stages. The gains from spill-ins are important to virtually all research organisations, but experience reveals that the smaller NARS tend to gain more than the larger NARS.

Figure 25.3: Returns with Spill-inns



Spill-Outs: Spill-outs refer to a situation where the research findings are used by other countries. If one is looking at the benefits and costs from the point of view of the country where the technology was developed, then this could be ignored. On the other hand, if one is interested in the total benefit accruing to both the country where it was developed as well as in the country where it was also adopted, then the spill-outs are important. Spill-outs increase the total social returns to research as shown in Figure 25.4. This aspect is critical in performing impact assessments within a regional networking context. Maximising technological spill-overs is the primary economic motive behind regional networking.

Figure 25.4: Returns with Spill-outs



Knowledge spill-overs

A network can produce production technology, as well as, research and development (R&D) technology (Nores, 1988). Production technology refers to all methods that farmers, market agents, and consumers use to cultivate, harvest, store, process, handle, transport, and prepare food crops, industrial crops, and livestock for consumption. R&D technology, on the other hand, refers to the organisational strategies and methods used by research and extension programs in conducting their work. Examples are:

- Scientific procedures;
- Organisational models; and
- Institutional strategies for program planning, evaluation, training, networking, etc.

The benefits of the R&D technologies can spill-over from one commodity to another. Often the same individual trained by a project in a specific commodity area is also requested to handle other commodities. Another example may be the methods and techniques that are developed by the project for a given commodity that could be applied to other commodities also. It is often difficult to estimate the monetary benefits of such spill-overs, but it is important to recognise them.

Spill-Over Effects and Regional Networks

The regional research networks should aim to maximise the spill-over effects of technologies developed. In terms of establishing research programs where direct spill-over is high, relatively few targeted research programs or stations are required. When substantial geo-climatic inhibitions to spill-over exist, more targeted programs to smaller regions are required to improve the research efficiency and productivity.

Indirect research spill-overs, however, are less inhibited by geo-climatic factors and are more important regionally and internationally.

Approaches to Estimate ROR Incorporating Spill-Over Effects

A generally accepted economic surplus model for research evaluation was first developed by Edwards and Freebairn (1981, 1982). This was a two-region traded-goods model that included an allowance for spill-over between the two regions. These regions are usually geographically/politically defined, and in their case one country and the rest of the world. From this a basic multi-regional traded-goods model was developed by the same authors in 1984 and extended by Davis, Oram, and Ryan (1987). Davis et al., used a multi-regional international trade model using the concept of economic surplus to derive ex-ante measures of the relative benefits of alternative commodity and regional research portfolios and the distribution of these benefits among consumers. They used agro-climatic zonation work to identify the agricultural production environment.

The formulae to estimate research benefits developed in Davis, et al (1987) incorporated the estimate of the final monetary value of the spill-over in terms of unit cost reduction. In Edwards and Freebairn (1984) and the empirical application thereof in Davis, et al. (1987), a spill-over index vector or matrix was used. The spill-over index is the ratio of the unit cost reduction in the specific production environment. For example, assume a technology is produced in production environment A, then:

$$C_{aa} = \frac{K_{aa}}{K_{aa}} = 1$$

where: C_{aa} = *Spill-Over Index*

K_{aa} = *Unit Cost Reduction in Production Environment A*

For the production environment B where the technology could be used:

$$C_{ab} = \frac{K_{ab}}{K_{a\,a}}$$

where: K_{ab} = *Unit Cost Reduction in Environment B*

In general:

$K_{ab} < K_{aa}$ *Due to Positive Adoption Cost*

and:

$0 > C_{ab} < 1$

To operationalise this model, one needs both objective as well as subjective data. The objective data includes (for each region/country) the quantity produced, quantity consumed, domestic price, elasticity of demand, elasticity of supply, and the exchange rate. Subjective data (in an ex-ante analysis) includes information related to direct and spill-over effects of research. In general, to incorporate the likely spill-over affects in the assessment of research priorities (based on impacts) the following information is needed:

- Supply and demand conditions in other producing and consuming countries to the one where research is to be conducted;
- An estimate of the size of the spill-over effect "K_{ab}" relative to the size of the direct effect "K_{aa}" (ratio of the vertical shift in supply curves - the spill-over index); and
- The differentials in probabilities of success, adoption levels and research lags among candidate countries.

In the absence of this information, one could modify the procedure using the cost-saving method. This simple procedure is described below:

- Step 1
  Select the commodity to be studied and assemble data country by country on area, production, and consumption of those commodities.

- Step 2
  - Define agro-climatically homogenous regions among the member states/countries where the technology can be adopted; and
  - Subdivide the countries by agro-ecological zones for the commodity under consideration. Identify the percentage distribution of each country's production (or area if production data are not available) by agro-ecological zone. In other words, relatively homogenous research domains for that commodity are defined and determine the production share by production environment. Estimates are often based on existing production levels.
- Step 3
  Collect information on the diffusion pattern, including adoption ceilings for each country within the homogenous region. If it is an ex-ante analysis, estimate the probability of success of research for each country and the ceiling level of adoption.
- Step 4
  Construct a table of spill-over effects from research undertaken in any one homogeneous region/country or the unit cost saved in each of the environments using a simple partial budget.
- Step 5
  Use this information to estimate the total benefit including the spill-over effect.
- Step 6
  Compile the cost of research, extension, and complimentary services in order to estimate the net benefit and ROR.

For example assume (see Table 25.1 & Table 25.2):

- Country A is developing a technology, say a new variety. The same technology can be adapted in three other countries (B, C, and D), but requires some adaptive research;
- The pre-technology production levels in each country are: Q_A, Q_B, Q_C, and Q_D, respectively;
- Based on partial budgets for each of these countries, the cost-savings per unit were estimated. This is denoted by: K_A, K_B, K_C, and K_D respectively;
- The diffusion pattern and adoption ceiling were also estimated for each of these countries/agro-ecological zones within a country;
- The cost of research, extension, and complimentary services was collected. Note that the adoption cost incurred by the farmer has already been incorporated into the partial budget;
- The adoption ceiling is reached in five years in Country A, and six years in the other three countries; and
- Research has been carried out for five years before the technology was ready for use by farmers in Country A.

Table 25.1: Data collected estimating gross benefits including spill-overs using cost-saving method

	COUNTRY			
	A	**B**	**C**	**D**
Pre-Technology Production	Q_A	Q_B	Q_C	Q_D
Cost Savings	K_A	K_B	K_C	K_D
Adoption Rate: (Percentage)				
Year 1	20			
Year 2	30	15	20	18
Year 3	45	30	25	32
Year 4	60	40	35	35
Year 5	70	50	45	37
Year 6	70	60	50	40
Year 7	70	65	60	50
Adoption Ceiling – Year 8	70	65	60	50
:	:	:	:	:
Year n	70	65	60	50

Table 25.2: Estimating gross benefits of research

	COUNTRY	

	A	B	C	D	TOTAL
Year 1 - 5		0	0	0	0
Year 6	$Q_A * K_A * .20$	0	0	0	∑ (A+B+C+D)
Year 7	$Q_A * K_A * .30$	$Q_B * K_B * .15$	$Q_C * K_C * .20$	$Q_D * K_D * .18$	∑ (A+B+C+D)
Year 8	$Q_A * K_A * .45$	$Q_B * K_B * .30$	$Q_C * K_C * .25$	$Q_D * K_D * .32$	∑ (A+B+C+D)
Year 9	$Q_A * K_A * .60$	$Q_B * K_B * .40$	$Q_C * K_C * .35$	$Q_D * K_D * .35$	∑ (A+B+C+D)
Year 10	$Q_A * K_A * .70$	$Q_B * K_B * .50$	$Q_C * K_C * .45$	$Q_D * K_D * .37$	∑ (A+B+C+D)
Year 11	$Q_A * K_A * .70$	$Q_B * K_B * .60$	$Q_C * K_C * .50$	$Q_D * K_D * .40$	∑ (A+B+C+D)
Year 12	$Q_A * K_A * .70$	$Q_B * K_B * .65$	$Q_C * K_C * .60$	$Q_D * K_D * .50$	∑ (A+B+C+D)
Year 13	$Q_A * K_A * .70$	$Q_B * K_B * .65$	$Q_C * K_C * .60$	$Q_D * K_D * .50$	∑ (A+B+C+D)
:	:	:	:	:	:
Year n	$Q_A * K_A * .70$	$Q_B * K_B * .65$	$Q_C * K_C * .60$	$Q_D * K_D * .50$	∑ (A+B+C+D)

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ENVIRONMENTAL IMPACT ASSESSMENT

Introduction

Agricultural technologies can have both positive and negative effects on the natural environment. A comprehensive impact assessment of R&D investment should consider these externalities prior to making decisions. Efforts are often made to integrate environmental and human, or social, impact assessment. In this chapter, the different types of environmental and social impact of technologies are defined, environmental impact assessment components, including attention to human welfare and social issues, are outlined, and finally guidelines for environmental impact assessment are presented.

Definition of Environmental and Social Impact Assessment

An environmental impact assessment (EIA) is an activity designed to identify and predict the impact of an action on the bio-geophysical environment, on mans' health and well-being, and to interpret and communicate information about the impacts (Munn, 1979). This should be based on an understanding of physical and biological effects as well as the social implications of a project or policy. In any case, environmental impact assessment should be an integral part of planning research and development projects and should be carried out at the same time as technical, economic and socio-political assessment.

Importance of Environmental Impact Assessment

Environmental impact assessments (EIA) are important because the non-market effects of a technology may be significant. EIA is becoming increasingly important due to concerns for ecologically sustainable development. In the past, in the majority of impact assessment studies, less direct environmental effects (positive, negative variable costs) have been assumed to be minor and have effectively been ignored. EIA is important for two primary reasons. Exclusion of EIA may:

- Affect the accuracy of the estimates of their net value and rankings, which may not reflect their relative potential net social benefit, leading to inefficient resource use; and
- If externalities are positive and substantial, the case for public funding of research may be strong.

Types of Environmental Impacts

Environmental Impacts can be of the following types (Labulwa and Davis, 1994):

- On-site market impacts;
- On-site non-market impacts;
- Off-site market impacts; and
- Off-site non-market impacts.

On-site market impacts

The on-site market impacts are those that affect only one site, do not have downstream effects and can be evaluated using conventional markets. An example of that is soil mining (soil degradation) - loss of nutrients when farming systems that do not adequately replenish the nutrients used. These effects are specific to the site that is affected, but they have intra-temporal as well as inter-temporal effects on the productivity of the soil. These impacts are reflected in yield losses and can be valued using the market prices for the relevant crops.

On-site non-market impacts

On-site non-market effects are those that affect only one site but are not reflected in the marketplace, e.g. slash and burn systems. These affect the biological diversity on-site, but the loss of biodiversity cannot be valued using conventional markets. Contingency valuation techniques are needed to evaluate such an impact.

Off-Site market impacts

Off-site effects concern individuals and communities downstream from where the activity generating the impact is undertaken. Examples are:

- Downstream effects including silting reservoirs, rivers, irrigation canals; and

- Reduction in water storage capacity of reservoirs and irrigation capacity.

These render water more costly and/or increase dredging costs for rivers and harbours.

Off-Site non-market impacts

Off-site non-market impacts are effects that affect downstream communities on sites different from where the impact originated, and they will affect individuals of generations that succeed the one that undertook the pollution activity. A good example of this is the atmospheric pollution resulting from an agricultural activity, such as the use of methyl bromide for soil fumigation leading to the depletion of the ozone layer. Another example is deforestation and its effects on the catchment area.

In order to quantify and value the environmental impact of an agricultural research initiative, it is important to understand the source of the impact, the nature of an impact, and the relationship between the impact and those variables that can affect current, potential or future producers and consumers. The best known attempts at quantifying the environmental impacts are concerned with soil erosion. In terms of valuation, the most difficult ones are those dealing with biodiversity and their benefits and costs requiring the use of contingency valuation. This may be due to the fact that the costs of establishing these values for inclusion in project evaluation may be prohibitive and/or may require longer time to do a proper contingency evaluation study.

Environmental Impact Assessment Components

An environmental impact assessment should contain the following:

- A description of the proposed actions and of alternatives;
- Prediction of the nature and magnitude of environmental effects (both positive and negative);
- An identification of human concerns;
- A listing of impact indicators as well as the methods used to determine their scales of magnitude and relative weights; and
- A prediction of the magnitudes of the impact indicators, of the total impact for the projects, and for alternatives.

Environmental impacts should be assessed as the difference between the future state of environment if the action took place and state if no action occurred. Methodologies for impact assessment should be selected which are appropriate to the nature of the action, the data base, and the geographic setting. Approaches which are too complicated or too simple should both be avoided.

Environmental management strategies that include estimates of long-term impacts undoubtedly challenge the traditional decision-making process. The political and economic bases for action are tuned to the immediate and short-range influences of the marketplace. Here, cost-benefit analyses are based on interest rates related to present-day costs of investment capital, modified to account for uncertainty and risk, and thus, with a time scale of 10-15 years. The economic system aims to maximise gains over the short-term, while ecological considerations suggest ways to minimise liabilities over the long-term. In addition to time-scales, several space-scales should be considered, i.e., the immediate surroundings, the neighbourhood, wider areas. When a project or program is undertaken, it sets in motion a chain of events that modifies, the state of the environment and its quality. If the projects were not undertaken, the environment would still exhibit:

- A greater variability - variations in weather and climate, and natural ecological cycles and successions;
- Irreversible trends of natural origin, e.g., long-term trends in the composition of soils; and
- Irreversible trends due to a combination of natural and man-induced facets, e.g., over-grazing, salinization of soil, deforestation, etc.

The reference condition is that "without-action" condition and, because of naturally occurring changes, it is not necessarily the present condition. Environmental assessment should be a continuing activity not only prior to the decision point but also afterwards, see Figure 26.1. Predictions, particularly ecological and sociological factors are somewhat uncertain. What then should be done if environmental behaviour begins to diverge significantly from its predicted states?

An environmental impact assessment should contain three subsections relating to environmental effects:

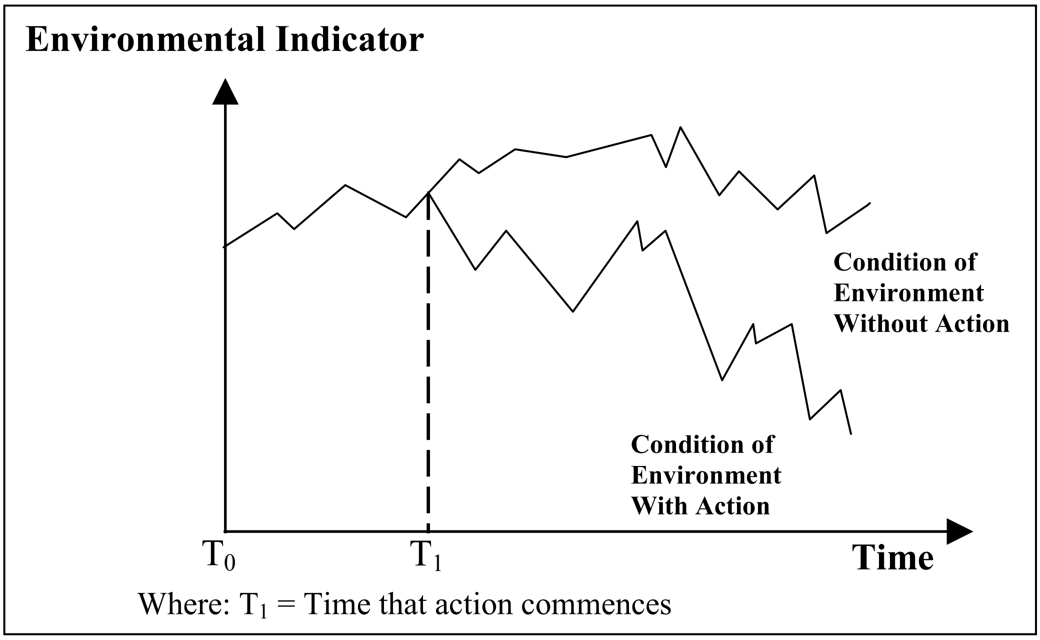
- A determination of the initial reference state;

- An estimate of the future state "without action"; and
- An estimate of future state "with action."

25.5.1 Establishment of the Initial Reference State

In fact, it must be emphasised that the establishment of an initial reference state is difficult. Not only are environmental systems dynamic, but it contain cyclical and random components. Therefore, a description of an existing environmental state still contains a degree of subjectivity and uncertainty.

Figure 26.1: Conceptual Framework for Measuring Environmental Effect



Predicting the future state in the absence of action

In order to provide a fair basis for examining the impact of the technology/project, future environmental states in the absence of action must be estimated. This part of the analysis is largely a scientific problem requiring skills drawn from many disciplines. The prediction will often be uncertain, but the degree of uncertainty should be indicated in qualitative terms at least.

Predicting the future state in the presence of action

For each of the proposed actions, there will be an expected state of the environment which is to be compared with the expected state in the absence of action. The probably adverse consequences of any development must be weighed against estimated socio-economic benefits, and identify the areas of human concern for each proposed action.

An Impact Indicator

An impact indicator is an element or parameter that provides a measure (in at least some qualitative sense) of the significance of the effect, i.e., the magnitude of an environmental impact. Some indicators have associated numerical scales. Other impact indicators can only be ranked on simple scaling such as "good-better-best" or "acceptable and unacceptable." The selection of a set of indicators is often a crucial step in the impact assessment-process.

For each proposed action, and for each of the human concerns, the expected outcomes can be compared on numerical scales. The original measurement units for the impact indicators will normally be quite different, i.e., some may be numerical while others are in the form of a series of classes. At this point in the analysis, there is a need to convert the scales into a comparable set using some systems of normalisation. In the most primitive system, each indicator is rated as being:

- Significant positive,

- Insignificant, or
- Significant negative.

The number of positive and negative counts is then compared. Because some human concerns are frequently more important than others, however, a series of weights may be assigned to the concerns.

There are three principal methods for identifying environmental effects and impacts (Sorensen and Moss, 1973, Warner and Preston, 1973):

- Checklist;
- Matrices - can be used to identify cause-and-effect relationships; and
- Flow diagrams - permits the analyst to visualize the connection between action and impact. This method is best suited to a single project assessment.

Ranking alternatives within impact categories

Based on the effects table or identified impacts projects can be ranked. Once again a multi-criteria approach is recommended (see Chapter 28 for more details).

Weighting

Conditions for normalisation and mathematical weighting are:

- The impact indicator scales must be comparable units; and
- An objective method for assigning numerical weights must be selected. The use of weights is not perfect, but it helps to quantify value judgements. In this case, the net environmental impact is expressed as a single value, it is easily compared with other alternatives to determine the most environmentally sound approach to development of a particular resource.

An impact assessment should be in a form suitable for making a decision, and that decision making is simplified if the major impacts are collapsed to a single number. In reporting the results:

- The desegregated values of the individual impact indicator should be given; and
- The procedure for aggregation should be clearly documented.

Uncertainty in Environmental Impact Analysis

Environmental impact analysis has four kinds of uncertainty:

- The natural variability of the environment;
- Inadequate understanding of the behaviour of the environment;
- Inadequate data for the region or country being assessed; and
- Socio-economic uncertainties - most difficult to quantify.

A related problem is due to the fact that uncertainty increases as the prediction is made for times further and further into the future. In some cases, predictions of long-term consequences may be so uncertain that the decision maker has no option but to make decisions on the expected short-term impacts.

Guidelines for Environmental Impact Assessment

The basic question that needs to be asked is: will action significantly affect environment? If the answer to the question is yes, then there is a need to conduct environmental impact assessment.

- For every proposed R&D project, the environmental assessment should include:
    - A prediction of the nature and magnitude of environmental effects (positive and negative);
    - A listing of impact indicators, whereby effects can be monitored;
    - The identification of human concerns regarding environmental changes; and
    - A statement whether these could be incorporated within a market framework and their values elicited.
- The level of detail depends on:
    - Sensitivity of the affected environment and their social values;
    - Scale of the proposed technology;

  - Types of effects it could have;
  - The resources, scientific expertise, and time available; and
  - The cost of impact assessment relative to likely environmental value.

- Full environmental impact assessment requires complex analyses of physical, biological, social and economic procedures. This may also require long-term commitment to the relevant areas of cross-disciplinary research.

In the past, the multi-disciplinary nature of environmental issues has caused problems with the quality and general availability of data. For example, R&D efforts might lead to the development of fertilisers that have long-term negative effects on the soil. To incorporate such externalities in the R&D framework, the physical effects on soil would need to be monitored closely by scientists before their economic impact could be estimated.

Another problem is obtaining statistically reliable field specific data. Reconciling different levels of aggregation to obtain reliable estimates is another issue confronting the analysts. Many physical and biological models provide information at the low level of aggregation. For example, movement of pesticides through soils is determined by several factors, such as specific soil characteristics (physical and chemical), properties of the soil, the climate, crop management practices, etc. The problem is how to generate information that reflects the physical, biological, and economic diversity of the region/nation under study, and how to combine this information to yield reliable information about the region/nation.

- In the absence of data required for thorough analysis, it may still be possible to identify the nature of the social costs and benefits, together with the gainers and losers.

- The prediction of negative environmental side effects does not necessarily mean that the new technology should not be used. The net benefit may be sufficiently large to provide compensation to those who are harmed and still leave a net surplus to the society. This is a policy question that needs to be addressed.

Definition of Social Impact Assessment

Social impact assessment (SIA) is the process of assessing and managing the impacts of a project, plan, project or policy *on people* (Vanclay, 1999). SIA is often motivated by a philosophy or conceptual approach to development that emphasises the achievement of goals such as poverty alleviation and sustainable development. SIA seeks to examine social impacts at the individual and household level, and the community and institutional level.

A SIA may be required separately or as part of an EIA or comprehensive IA (Roberts, 1995). Many agencies include human and social impact in the EIA because social sustainability and ecological sustainability are to be considered in partnership (Vanclay, 1999). However, some donor agencies may propose a separate SIA or even a more focused, Gender Impact Assessment (see Annex for additional information). For instance, the World Bank has developed the Poverty and Social Impact Assessment (PSIA) approach to capture explicitly to "the distributional impacts of policy reform on the well-being of different stakeholder groups, with particular focus on the poor and vulnerable". (See the PSIA website for a case study on Cotton Reform in Chad and summary matrix of questions to guide the PSIA*: http://poverty.worldbank.org/files/12874_summarymatrix.pdf*).

Importance of Social Impact Assessment

The importance of conducting SIA is based on the following:

- The ‘success’, or ‘failure’ of an action cannot be fully understood if the perceptions of those who the intervention aims to benefit are not considered.
- The impact equity of a technology/project means that some actions may affect certain groups within society in different ways. Who wins and who loses with each alternative considered is a basic part of SIA.

Guidelines for Social Impact Assessment

There are similarities between the components of an EIA and the basic steps followed in a SIA. However, the focus in the SIA is on the social and cultural aspects of the environment, and social values of the community which exist largely in people’s minds or perceptions of their environment. The involvement of those affected by the action is essential in the SIA and must be taken into account at the outset (Roche, 1999).

As outlined by the General Services Administration of the U.S. Government (2003), the generic steps in SIA are:

1. Develop a plan for the involvement of the population in the affected area.
    - establish the general character of the population
    - define the potentially affected groups
    - identify the specific means for their involvement including how major constraints on participation will be addressed (e.g. language, literacy, etc.) and any processes required for their involvement (e.g. consultation with local leaders or experts)
2. The social analyst examines the need for the action and the identification of alternatives.
    - identify the key social issues in each alternative
    - determine if sufficient basic data is available for social analysis of each alternative
3. Define the baseline
    - describe the pertinent existing conditions in the affected population (i.e. households and communities) including relevant demographic, economic and cultural characteristics
    - address relevant historical background
    - identify political and social resources, power structures and networks of relationships in the population
    - identify special needs of vulnerable groups within the population
    - identify and describe the attitudes and perceptions of each affected group to the action and more generally, their environment
4. Define the scope of the SIA

The scope of the SIA should be focused to address the necessary issues and to identify the right methods for analysis. The scope of the assessment must be carried out *in consultation* with the affected groups and consider factors such as:

- probability that an event will occur
- number of people potentially affected
- duration of potential impacts
- values of benefits and costs to affected people (households and communities)
- potential for reversibility or mitigation
- likelihoods of subsequent impacts
- relevance to decisions
- uncertainties over probable effects
- controversy

5. Project expected impacts

Once the scope of the analysis has been defined the likely effects of the action can be projected, given the alternatives under consideration and the information available about the population and area in question.

The analysis makes use of secondary literature and information about similar actions or similar populations, census data and other statistics for the population and area under question, and field research.

The choice of methods used to analyse impacts will depend on the types and importance of the expected impacts (direct and indirect), and the availability of data, time and local capacity.

Field research methods can include interviews, surveys, focus groups, community meetings and discussions with local leaders and recognised experts, and participant observation. Participatory monitoring and evaluation methods are often used to identify and incorporate the different *perceptions* of those affected by the action.

The projections made in social analysis can include:

- comparative projections- comparing with similar actions and their effects
- straight line trend projections- projecting the existing trend into the future

- population multiplier- a unit of change in a given population implies change in other variables
- scenarios – logical or data based models played out
- expert advise on likely scenarios
- futures foregone- conditions in the absence of the proposed action

6. Predict responses to impacts

The analysis then examines what will happen as a result of the predicted impacts. What will change? What will be the likely responses?

7. Recommend new alternatives as needed and feasible

Given the serious impacts (direct and indirect) identified, what alternatives would reduce these likely impacts. Involvement of those affected by the action in determining alternative courses of action may require special mediation and conflict resolution efforts.

8. Develop a plan for mitigating social effects and monitoring the plan

Working with the affected people (households or communities), a plan can be developed to address ways to mitigate social effects. The plan should include attention to responsibilities and resources. Also included are mechanisms for monitoring the plan.

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PARTICIPATORY IMPACT MONITORING – (PIM)

Introduction

Participation has become a widely accepted strategy for planning, implementation and evaluation of R&D projects. The participatory approach values the input of the beneficiary and becomes associated with increasing the respect for and incorporation of indigenous knowledge, or beneficiary knowledge, in all aspects of a program or project. Participation occurs during the entire project cycle, namely: need assessment/problem identification, project/program design including feasibility analysis, project/program implementation; as well as monitoring and evaluation including impact assessment. The logical framework approach is often used to identify objectively verifiable indicators for this purpose. It has been argued by development practitioners that this so called traditional monitoring and evaluation cater for evaluating economic and technical impact and what is needed when dealing with communities is a system of monitoring that may address the 'softer', 'hidden' and 'informal' impact that the project may have on the target beneficiaries. These impacts are called 'socio-cultural impacts'. Traditional M&E systems are used to measure 'objectively verifiable indicators', whereas socio-cultural analysis, want to understand and develop qualitative indicators. Participatory impact monitoring (PIM) is an emerging method to assess the socio-economic impact of a project/program on the target beneficiaries – largely based on subjective judgement and perceptions of the stakeholders. The various aspects of PIM are discussed in this chapter.

Definition and Objectives of PIM

The whole process of evaluation since its inception has gone through several evolutionary stages. The current stage of development is called the Fourth Generation Evaluation. The fourth generation evaluation deals with both subjective and objective means of assessment. Participatory Impact Monitoring (PIM) is one of the fourth generation techniques and it uses subjective interpretations as foundation for evaluation.

PIM is defined as a "method that is used to evaluate the socio-cultural impact that a project has on the project environment". Several autonomous actors are involved in PIM. These may be, according to context: farmer groups, self-help groups, development organisation, NGOs, and the funding agency. These are what we usually call 'stakeholders' in a development project. PIM recognises the subjective perceptions of all stakeholders, or, in other words, PIM is based on the joint perception of impacts by stakeholders.

Monitoring of budget, activities, and project objectives are catered for by conventional M&E systems. Therefore, PIM focuses on subjectively important changes. And since many actors are involved in a project, and because a project has got many impacts of different kinds, it is important to recognise both quantitative as well as qualitative aspects in the assessment process.

PIM invites members and stakeholders to observe, reflect and make decisions with respect to a project. The practical purposes of monitoring are 'checking', reflection and learning. On the one hand, reflection takes time, but PIM argues that reflection, at the other end, saves time, because if you reflect you may avoid time-wasting activities. In this sense, it is being argued that "reflection is investment".

It is believed that the involvement of all stakeholders in the monitoring exercise will improve the realisation of the project's purpose. The objectives of PIM are then to:

- Gear activities to members' needs;
- Involve members in observation, reflection and decision making; and
- Strengthen the involved organisation's structures

In order for PIM to be applicable, stakeholders must be willing to be flexible and to face a change in the project, or operate according to the 'trial and error' technique:

- To move from more rigid schemes of evaluations to continuous monitoring;
- Move a little bit from the factual to the social level;
- To be more attentive to subjectively important changes rather than objectively verifiable indicators; and

- Begin to perceive trends rather than to determine exact information, and emphasise informal- rather than formal structures.

Against this background, the proponents of PIM argue that:

- Objectively verifiable indicators function mechanically; and
- In dealing with community based development programs one needs simple monitoring systems and indicators.

Key Elements in PIM

PIM is usually conducted by all levels of stakeholders in the form of groups. This adds an additional requirement for PIM to be effective, such as regular group meetings, the interest of members, willingness of group leaders to communicate, and that group members are willing to invest a little time in joint management.

To sum up, we may say that the key elements in PIM are the following:

- Interaction between the project actors. Each group of actors covers its area of interest. A systematic mode of observation is not achieved by accumulating data, but only through co-operation between actors. The project data and autonomous monitoring systems of the individual actors are discussed regularly at Joint Reflection Workshops. If the aims and perceptions of the individual actors differ, PIM may serve as an early warning system.

- Informal structures play a significant role in PIM. The significance of the informal structures is underlined by the existence of the different actors participating in monitoring. The observation criteria, indicators, and reporting only have to be suitable for the respective actors, so that they can make decisions.

- The more intangible the goals, the less exact the information that can be obtained. PIM is especially suitable when we are dealing with development goals, thus catering for the subjective interpretations of all actors involved.

- PIM wants to encourage actors to form hypotheses about their expectations. This means that since the goals of PIM are intangible, we cannot expect to obtain exact information. Even if the information is not accurate, it is first assessed within a group, verified and disputed and, if necessary, supported by additional perceptions from other group members. Therefore, the group serves as a filter and corrective mechanism. So, rather than perceiving objectively verifiable facts, PIM aims at discerning trends. This means that:
    - Inaccurate observations are permissible
    - No formal indicators are expected

PIM does not make a strict differentiation between changes, effects, and impacts. Firstly, PIM rather tries to identify the subjectively important changes at the beginning. Only in a second step does PIM determine how these changes are related to the activities of the project actors and, hence, they become effects. Thirdly, the performance and range of changes are determined by regular monitoring. Due to this "self-cleaning-mechanism", effects and performance are filtered out mechanically.

The key elements of PIM are regular observation and reflection at different intervals and to a different depth at the individual level. PIM can be used at any stage in the project cycle, since it is not based on formal specifications or plans.

PIM contains elements of both formal logic and network logic. Expectations, as we shall see below, turn into indicators, which may be used for purposes of formal logic. The different actors involved also provide PIM with a natural network logic. Additional spill-over effect is realised in the form of learning processes.

The Special Features of PIM

The special features of PIM are:

- Complementary to conventional, or formal, M&E methods;
- Goal oriented;

- Emphasises socio-cultural impact;
- Based on informal processes and structures;
- Indicators may not always be exact, but will however illustrate essential trends quickly and plausibly;
- Subjective evaluation is an important selection instrument. PIM wants a solution that is subjectively the best for all actors;
- Uses limited perceptions to recognise patterns and interpret them;
- Guided more by experience and intuition;
- Promotes autonomous activities of the stakeholders;
- Encourages co-operation and participation; and
- Self-help promotion by stakeholders

Steps in PIM

PIM is performed in several steps, and is ideally conducted simultaneously by all actors involved in their respective locations and at their respective levels. The different groups regularly exchange their information, perceptions, and interpretations at Joint Reflection Workshops, discussing their expectations and fears regarding the project, thereby enhancing the understanding between the groups. A systematic mode of observation is not achieved by accumulating data, but only through co-operation between actors. The more congruent the aims and expectations of the individual actors are, and the more they are in agreement with the overall project goals, the more smoothly and efficiently PIM will function. The aim of the Joint Reflection Workshop is to discuss and communicate the observations of those involved regularly. At this occasion observations are compared, the socio-cultural impact is analysed, decisions are taken, and, if necessary, measures and decisions may be taken to improve on the monitoring. The first year it may be useful for the Joint Reflection Workshop to meet every three months. After the first year, an annual meeting may be enough. In order to set up an effective PIM, several basic questions need to be answered.

What should be monitored?

The first step of PIM consists in determining what it is to be monitored. It is useful to monitor informal and comprehensible objectives, such as expectations and fears, and the effects that were not planned. The group should systematically monitor the changes that are important to them. We can say that PIM aims at collecting fears and expectations, by answering the following questions:

- “What changes do we expect from the project?”
- “What changes do we fear from the project?”

By means of prioritising, the group may then reach consensus and select 3-5 important aspects. This process should be dynamic. Therefore, the expectations and the fears should be corrected and refined continuously. The project team on their behalf may reflect over the issue: “Based on previous experiences, what socio-cultural changes do you expect or fear from the project?”.

How can it be monitored?

After having chosen some expectations and fears, the group should attempt at establishing some concrete examples of how it is possible to see if things are changing the way they want or not. Now you are looking for indicators! Here PIM does not ask for scientific solutions, but for practical ones, and relies on the collective knowledge of the group. In establishing the indicators continuous reflection is more important than gathering of hard data! This may seem a little bit difficult, and therefore PIM suggests four ways to establish indicators, out of which the appropriate one is to be selected:

- Measuring or counting;
- Scaling or rating;
- Classifying;
- Describing qualitatively.

Other stakeholders may wish to link with, if available, conventional M&E system at this step.

Who should monitor?

The responsible people for monitoring should be chosen at the meetings held by the group. By assuming the role of observers, members of the group learn to watch for relevant changes and to assume responsibility. It is important to stress, once again, that it is crucial that members are interested in follow-up and monitor the indicators and that they do that responsibly. Often members holding senior positions are chosen to avoid the creation of a parallel structure of power.

How can results be documented?

There is a need to keep a record of the indicators in the monitoring process. This note can be summed up as follows: "Always carry a notebook and a pen behind!" For example, if three people would visit a cattle market with the aim at establishing the market prices of different livestock, and do not bother about taking notes, it is quite possible that they will quarrel about the information received at the end of the day. Had they taken notes, there would have been peace in the team. Any way of recording is appropriate, such as tables, graphics, charts, and descriptions. However, the group may wish to keep some information inside the group, and not to be exposed at the Joint Reflection Workshops. It is important for the group to decide on this.

Another crucial step in the process is monitoring of reports. At the beginning of every group meeting, indicators are reviewed, and relevant changes are observed, following the presentations of the observers. The revision of indicators can be done by asking the simple question "What have we observed?" Following the presentation, there may emerge a discussion in a group as to whether other relevant changes have taken place!

Some useful questions at this step are:

- "Have the indicators changed?" If yes, this may lead to corrections and refinements of the indicators used.
- "What other important factors have changed?" This will indicate whether additional indicators ought to be observed.

The reports of the involved stakeholders are then presented at the Joint Reflection Workshop. As a loose guide for discussion, it may be useful to discuss the following topics together:

- "What has changed?"
- "What/who has changed?"
- "What has caused the change?"
- "How has it changed?"
- "How has this change affected you?"
- "What other change(s) has(ave) occurred as a result?"

It may appear at the workshop that the monitoring system needs to be revised or changed. This may happen if the following applies:

- If time shows that indicators are not useful!
- If new fears and expectations arise!
- If funding agencies need improved information flow! If this applies, the group must decide what they think about it, and negotiate with the external organisations!

Analysis - why these results?

It is important that the findings from the preceding step are reflected upon and discussed. Generally, the results of observation require analysis and discussion in the following situations.

- If things are always as expected, this is probably a success and it is worthwhile analysing occasionally why and how these results have been achieved!
- If the monitoring results show that there are problems that require decisions, the meeting should put the topic on its agenda immediately.

At this step, cause-effect relationships are not documented but can be prepared at any time. It is useful to analyse reasons for both good as well as poor performance.

What action should be taken?

After the analysis, the group defines its agenda and takes decisions. The decisions are based on factual reasons and the members are enabled to participate responsibly. The leadership of the organisation becomes more transparent and democratic.

However, the last step of taking action is not a final one. The action that we take will create new impacts on the project environment and each stakeholder will then be back at step one again and re-initiate the process of monitoring, establishing indicators, reflect upon those, and so on. The process of reflection will provide a useful point of learning from all actors involved: learning about ourselves, as well as learning from others.

Limitations of PIM

PIM is actually a very simple and easy monitoring system, once you become used to carry your notebook behind, and start looking for, and reflecting about, the indicators that you have selected. However, PIM has its limits. Some of them are that:

- PIM is only a concept and cannot be a solution to all problems.
- PIM is limited to a manageable number of dynamic elements.

Until we learn how to apply PIM and acquire the necessary experience in doing so, its value as a tool will be limited. PIM should always be used in conjunction with an objectively oriented M&E system.

It is worth noting that the comprehensive impact assessment framework proposed in this sourcebook includes the socio-cultural impacts also.

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Organisational Performance Assessment[3]

Assessing and Improving Organisational Performance

Organisational performance has become an important issue for agricultural research organisations as they face increasing demands to demonstrate that they generate relevant outputs for clients and beneficiaries.

This chapter introduces the concept of organisational performance and highlights both the importance of performance assessment and the link to performance improvement. Different approaches to performance assessment are briefly introduced. Lastly, a system of performance assessment for agricultural research organisations, for which the present guidelines were developed, is introduced.

What is organisational performance?

The issues of performance and organisational performance have received much attention since the early 1990s. While the "performance revolution" started in the private sector, its effects were quickly felt in the public sector – influenced by ideas from the "new public management" school that seeks to transfer concepts and processes from the private sector to the public sector, in order to make them more output oriented and accountable to stakeholders (Osborne and Gaebler 1993; Lusthaus, Anderson, and Murphy 1995; Lusthaus et al. 2002; Peterson 1998).

In general, "performance" refers to the need for organisations to be efficient producers of outputs that are relevant to the needs of stakeholders – this is the principal measure of their effectiveness. Performance in the public sector is closely linked to accountability: organisations are held accountable for a certain level of performance by their parent ministry or funding agency. For agricultural research organisations, performance refers to the need to contribute to agricultural innovation and to generate technologies relevant to the needs of producers and agro-industry. Hence,

> *organisational performance may be defined as the ability of an organisation to use its resources efficiently, and to produce outputs that are consistent with its objectives and relevant for its users.*

Yet, while the general elements of organisational performance (efficiency, effectiveness, and relevance) are widely shared (Lusthaus et al. 2002), there is no simple or universally recognised definition of what performance is at the level of an individual organisation. The performance of an organisation is closely linked to the goals and objectives it wants to achieve. Specific performance elements need to be defined and agreed by the organisation. Performance, in other words, is a "socially constructed reality" that exists in people's minds (Mayne and Zapico-Goñi 1997a, viii).

Agricultural research organisations, for example, may define performance based on the quantity and quality of scientific publications produced, or they may define performance in terms of technologies adopted by farmers. Because performance is a reflection of an organisation's goals and strategic objectives, performance measures have to be tailored to the conditions and needs of the organisation. They also have to be acceptable within the organisation and credible to outside stakeholders.

Why assess performance?

The ability to define, measure, and evaluate performance is an essential condition for an organisation's improvement. In many agricultural research systems the capacity to conduct research is well established and the key constraints to improved performance appear to be organisational and managerial in nature.

Before an organisation can improve its performance, it needs to be able to measure and evaluate its present performance. For assessing the performance of agricultural research organisations, two kinds of approaches are relevant: those that assess *organisational performance in general* (Austin 1996; Mayne and Zapico-Goñi 1997b; Lusthaus et al. 2002; Kaplan and Norton 1992; Rummler and Brache 1995; Schacter 2000) and those that focus on assessing *research performance* (Szakonyi 1994 a and b; Shumann, Ransley, and Prestwood 1995; Alex 2001; Hartwich 1998).

Periodic assessments not only help research organisations to improve their performance over time, but also provide a means of communicating performance information to stakeholders. While in the private

3 This Chapter is adapted from Peterson, W, G. Gijsbers, & M. Wilks. (2003) An Organizational Performance Assessment System for Agricultural Research Organizations: Concepts, Methods, and Procedures. ISNAR Research Management Guidelines No. 7. The Hague: International Service for National Agricultural Research.

sector market share and profitability provide fundamental indicators of a company's performance, such measures do not directly apply in public-sector organisations (even if the organisation has to generate external income). Mechanisms to assure accountability are instrumental in improving performance, but they are also important in accounting for public resources used and results achieved.

It is particularly important for agricultural research organisations in developing countries to assess their performance because many are facing a crisis of confidence that is associated with:

- stakeholder dissatisfaction;
- decreasing investor confidence and reduced funding;
- inward looking attitudes;
- top-heavy, bureaucratic procedures;
- a "brain drain" from the public sector;
- the lack of effective external linkages;
- limited research and service outputs.

These research organisations are challenged to improve their performance by increasing the relevance of their outputs to producers and society and by addressing demands for good management and accountability, as well as impact. The ability to assess organisational performance and communicate the results can help reorient research organisations towards the production of more relevant outputs and to restore stakeholder confidence. However, evaluation is weak in many national agricultural research systems and is seldom used to improve decision making related to organisational performance. Among the reasons for this weakness are the following:

- Evaluation is often an isolated activity, carried out to meet donor requirements, and not targeted at crucial internal management issues.
- Evaluation methods are often complex and expensive; they may require excessive data and paperwork, and are therefore difficult to organise.
- Evaluations are often not well integrated with the planning process.

As a result there is little systematic information flow to support management decisions. This makes it difficult to identify structural, organisational, or managerial problems that constrain performance, or (equally important) to demonstrate improvements in research outputs and outcomes when these are achieved.

Evaluating the performance of public-sector agricultural research organisations poses some special problems:

- First, farmer adoption of research outputs is influenced by many factors (including changes in the broader policy environment) and actors (such as extension organisations, seed companies) outside the control of the individual research organisation.
- Second, public-sector research organisations have multiple social and economic objectives – rather than the single objective of maximizing profitability, that motivates most private-sector entities. Contributions to broader development goals, such as poverty alleviation, are often difficult to attribute.
- Third, public sector agricultural research organisations are accountable in a variety of ways to diverse stakeholders (including various types of producers, industry, government, donors, universities, and nongovernmental organisations [NGOs]).
- Finally, public-research organisations seldom have the flexibility to introduce and apply appropriate staff-evaluation systems – in particular, evaluations that can be translated into rewards for good performance and sanctions for poor performance.

Performance management

Performance assessment is only one of several steps towards improving performance; performance management guides the process, from assessment to eventual improvement. First, performance needs to be defined in relation to the specific tasks and mandate of the organisation. Second, performance needs to be measured using appropriate indicators. Third, the measured performance needs to be evaluated. Finally, if performance is found to be inadequate, action needs to be taken to improve it. Performance assessment is of limited value if it is not followed through with specific actions aimed at solving output- and management-related problems.

Performance assessment will be most effective if performed at regular intervals, since this allows comparisons of performance over time. Not all problems, however, can be addressed at the level of the organisation itself. In most cases, the management of an institution faces external constraints to improving its performance. Such constraints need to be addressed at a higher level – for instance at the level of the parent organisation or ministry, or at that of the national civil service or government.

Approaches to performance assessment

Adopting performance assessment represents a shift of attention from inputs and internal processes to emphasising outputs for clients and outcomes for stakeholders and the general public. With regard to agricultural research organisations four types of evaluation can be undertaken:

- economic evaluation of research outputs and outcomes;
- program evaluation approaches;
- performance audits;
- organisational performance assessment models.

This chapter deals with the performance assessment of agricultural research organisations.

Organisational performance assessment has its roots in the field of management theory. The development of performance measurement systems that often include a variety of quantitative and qualitative indicators or metrics has become an important area and has received much attention from academic researchers as well as from management consultants.

Worldwide, public- and private-sector organisations are confronted with increased demands for accountability and performance. As a result, many have put considerable effort into defining what performance is, measuring performance, and benchmarking performance vis-à-vis competitors and collaborators in the field. Private-sector organisations have sought to expand the concept of performance beyond a short-term assessment of the financial bottom line to include a variety of other indicators that focus on long-term value creation such as customer service, quality of internal processes, and organisational learning (Kaplan and Norton 1996). Interest in, and use of, performance measures in public-sector organisations has also grown (Mayne and Zapico-Goñi 1997b). In the USA a major push to performance assessment has been given by the Government Performance and Results Act (GPRA), which requires all public-sector institutions to specify goals and objectives (to be presented in strategic plans) against which performance can be measured (NSF 1995). The GPRA has generated considerable interest in the measurement of performance through the development of performance indicators. In South Africa the Public Finance and Management Act (Act 1 of 1999) require the same of government department and all institutions receiving government funding.

OPAS: Performance assessment for agricultural research

A comprehensive organisational performance assessment system (OPAS) for agricultural research has been developed by the International Service for National Agricultural Research (ISNAR). Its purpose is to assist public agricultural research organisations in being more performance oriented in the face of reduced funding, increased competition from other actors, and increased demands for accountability, research performance, and evidence of impact. Drawing on government audit and corporate practices (Mosher 1985; Moynagh 1993; Faucett and Kleiner 1994; Szakonyi 1994a), evaluation concepts and methods were adapted to the needs and conditions of agricultural research. The OPAS treats agricultural research organisations as research production systems, the main elements of which are presented in Figure 28.1. The relationship between these elements can be summarised as follows:

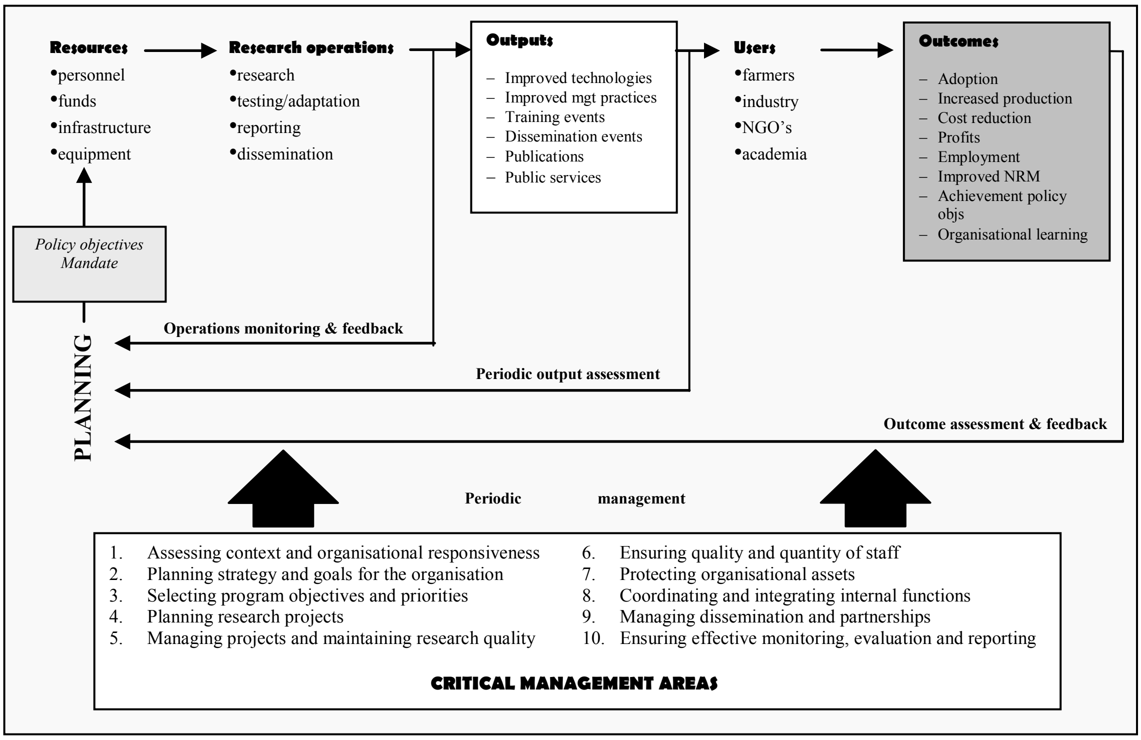
> Agricultural research organisations use *resources and inputs* (funds, personnel, equipment, and facilities) to undertake their *research operations* in order to produce *outputs* (agricultural technologies and services) for the benefit of farmers, agro-industries, and other users. The *outcomes* (or consequences) of adopting or applying these outputs are measured by their effects, positive or negative, on such factors as production costs, yields, and use of natural resources. In this sequence of events, which is illustrated in the upper part of the diagram, *performance assessment and feedback mechanisms* are required at different levels to ensure that research organisations plan their resources efficiently and produce relevant and useful outputs.
>
> Planning, management, and decision-making processes directly affect research operations, output productivity, and relevance – and therefore also need to be examined from time to time. An underlying assumption in organisational performance is that it is driven by a number of *critical management factors*, as indicated in the lower part of the diagram. Through a *periodic assessment* of these factors, managers can determine if appropriate mechanisms and procedures are in place and functioning, and can take steps to correct management deficiencies that

contribute to poor (or lower) organisational performance. The assessment also provides information on constraints to performance, including external constraints (such as inadequate funding for research, noncompetitive salaries, or bureaucratic civil-service procedures), which managers can relay to higherlevel decision makers and investors.

The elements in the white boxes in Figure 28.1 – outputs and management processes – can be addressed as part of a single process. National teams that recently applied the OPAS have estimated that two weeks of working full-time are sufficient to complete data collection and analysis for these two aspects of organisational performance assessment (ISNAR 2001).

The shaded part of Figure 28.1 (outcome assessment) has to be addressed as a separate and more complex process, involving longer-term survey and sampling work. It requires additional resources invested over time to track technology adoption and its results. It provides, however, an important complement to organisational performance assessment and should be carried out to determine organisational *relevance* (are research outputs being adopted or applied and are they consistent with government development objectives?), and *results* or *impact* (are outputs benefiting producers or other users and are they contributing to increased production?). Outcome assessment procedures should focus on establishing direct causal links between specific outputs from the organisation and its various beneficiaries.

Figure 28.1: Elements of organisational performance assessment



OPAS represents a shift in perspective, away from externally driven evaluation of programs or projects, which are often done for the benefit of outsiders, towards internally driven assessment aimed at improving organisational performance. The most significant advantages of internal performance assessment are that it

- identifies and measures all outputs produced by the organisation;
- emphasises productivity and relevance in terms of outputs and outcomes;
- addresses crucial internal management issues and constraints;
- creates ownership and consensus;
- yields fairer and more realistic recommendations;
- improves internal and external transparency;
- builds on staff knowledge regarding the strengths, weaknesses, and constraints of their organisation;
- promotes staff participation, teamwork, and communication;

- promotes objectivity through consensus and agreement, and through the use of external facilitators.

The OPAS produces information that is useful for:

- demonstrating and reporting organisational performance (to managers, investors, external evaluators, and the general public);
- correcting the causes of poor performance;
- raising awareness about constraints to performance;
- improving resource acquisition and stakeholder support.

With its emphasis on self-assessment, the OPAS is not designed to compare the performance of different organisations, but to measure and track performance within a given organisation. Implemented by organisation managers and staff, its principle objective is to guide internal planning and decision making, although the assessment results can also be used for external reporting. Objectivity in self-evaluation can largely be addressed by using a facilitator (or facilitators) to guide the process.

In section 1.2, OPAS methods for assessing organisational outputs and management processes are described and examples of their application provided. These are followed, in section 1.3 by a description of what is needed to plan and implement the assessment process.

OPAS: A Step-by-Step Approach to Performance Assessment

This section deals with two components of organisational performance[4]. It presents a step-by-step approach to *output assessment* and *management assessment* for agricultural research organisations, based on the concepts outlined in section 28.1.5. In both cases, examples drawn from real-life assessments are provided to help clarify the accompanying text and to illustrate the progression from one step to the next.

Output assessment methods

The main purpose of the output assessment is to evaluate the organisation's *productivity* in terms of research and service outputs, and the extent to which these contribute to the goals of the organisation. As Figure 28.2 indicates, output assessment in the OPAS involves ten basic steps. The methods developed to implement some of these steps are highlighted in the diagram. They include procedures for identifying and measuring organisational outputs, and for analysing the output data. These procedures and the individual steps required to implement them are described below.

Output identification

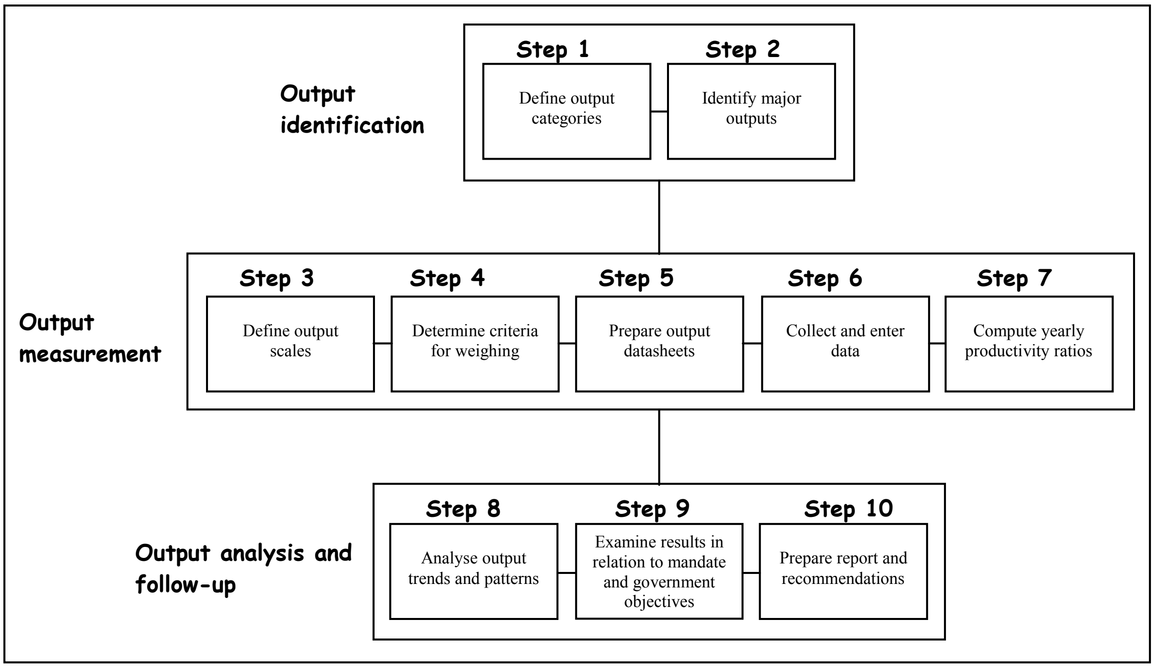
Many organisations have an incomplete picture of the outputs they produce. This can result in important activities being overlooked when reporting to investors and stakeholders, and when planning future operations and resource use. In agricultural research organisations, some outputs (such as advisory services, training courses, student supervision, maintenance of genebanks and reference collections) are often unreported because they are not mentioned in the mandate or because records are not kept.

Output identification is a necessary step in communicating to the outside world what is being produced and/or delivered in terms of technology and services. It also serves as an indication to organisations that new forms of record keeping may be needed.

Step 1: Define output categories. For evaluation purposes, it is important to identify all major outputs of an organisation. Grouping them under a limited number of categories will simplify the assessment process. The first step of output assessment is, therefore, to define the output categories. To avoid problems of overlap, these need to be carefully selected. Well-defined (mutually exclusive) categories are also more likely to be maintained, making it easier to compare performance over time.

Figure 28.2: Output assessment methods used in the OPAS

[4] *Outcome assessment* is a substantially different process from output or management assessment, both in nature and time requirements.



Six output categories that are common to most agricultural research organisations are used in OPAS as a basis for output identification and assessment:

- production and research technologies;
- dissemination events;
- crop/livestock management practices;
- publications and reports;
- training events;
- public services.

The proposed set of outputs categories can be adapted by individual organisations to suit their specific needs. In some cases, organisations may add categories to highlight certain activities (such as income generation) that is of particular importantance to them, or may delete one or more of the proposed categories because they are not applicable to the organisation. Flexibility is important, but should be balanced against the desirability of achieving a degree of clarity and simplicity.

Step 2: Identify major outputs. The next step involves identifying specific types of output produced by the organisation and listing them by category, as defined. Examples of outputs produced by agricultural research organisations are indicated in Table 28.1. The assessment team should involve other staff in the discussion of outputs and reach agreement with management on the final list before proceeding to the next step.

As a rule, *intermediate outputs* (such as research proposals, progress reports, internal documents, and some types of laboratory analyses) are not assessed, since they are not produced for the benefit of farmers or the scientific community.

Basic-research outputs may be considered for assessment if basic research constitutes a major activity in the organisation, and if the research findings (such as successful pathogens or genetic markers) are used by outside agencies. It is suggested that basic-research outputs benefiting the scientific community should be included in the technology category.

Table 28.1: Framework for Output Identification

Output categories	Examples of outputs
Production and research technologies	• improved plant/animal varieties • improved laboratory methods • crop-related technologies (irrigation, pest control, plant nutrition, etc.) • livestock-related technologies (animal-feed formulas, embryo- transplant methods, artificial-insemination methods, etc.)
Crop/livestock management	• post-harvest recommendations

practices	• plant-protection recommendations • animal-health recommendations • nutrition-management recommendations • feeding-management recommendations
Publications and reports	• Books • journal articles • research reports • conference proceedings • consultancy reports • training manuals • advisory leaflets • maps • posters
Training events	• farmer training • extension training • researcher training
Dissemination events	• field days • open days • farm trials. • Exhibitions • media events • workshops and seminars
Public services	• surveys (pest, disease -monitoring, etc.) • land-use mapping • germplasm conservation • seed production and distribution • vaccine production and distribution • quarantine services • quality-control services • policy studies, recommendations • student supervision

Note: This framework for output identification needs to be tailored to the activities of individual organisations.

Output measurement

Productivity measures (defined as output divided by input) are used to determine the quantity of outputs produced in relation to available resources. Using scientist time as a proxy for input use provides a reasonably good indication of productivity over time. Scientific staff can be seen as the resource most closely related to an organisation's outputs. Compared to other resources, it does not change significantly from year-to-year in public-sector organisations. And, more importantly, information on the number of full-time research staff (usually those at BSc, MSc, and PhD levels) is readily available at most institutions.

Productivity ratios are calculated by dividing *output scores* identified for a given period by the amount of *scientist time* available in the same period. The use of ratios allows managers to track output performance over time.

Four basic elements are needed to develop a productivity measure: a scale for scoring the outputs, criteria for weighting the outputs, raw output data, and formulae that compute the scores and ratios. The steps for completing this part of the assessment process are described below.

Step 3: Define output scales. Once the outputs have been identified scoring scales need to be defined for each output category[5]. Each scale should indicate the lowest and highest possible numbers of outputs produced in a year. As the examples below illustrate, values on the scale can be whole numbers or ranges of numbers.

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[5] In most organisations that have implemented the OPAS, scoring scales were developed prior to *data collection* (Step 6), and then adjusted if necessary. In a few cases, where it was difficult to estimate the quantity of outputs produced, scales were defined on the basis of output information collected. Whether scale development should precede or follow data collection, i.e. that the appropriate sequence of steps, very much depends on the size of the organisation and the extent to which assessment team members are familiar with the various outputs produced by the organisation - .both are valid.

A score is assigned to each value. The examples show scores ranging from 0 to 4, but a 1-to-5 range can also be used. The same range of scores should be applied to all output categories.

Example 1: Release of new technologies — **Scale :** *Number of technologies per year*

Scale	0	1	2	3	>3

Example 2: Training of extension agents — **Scale :** *Number of participants per year*

Scale	<10	10-30	31-50	51-70	>70
Score :	0	1	2	3	4

It is important that the scoring scales be based on realistic numbers or ranges. A single scale can be developed for an output category, if its values are applicable to all outputs in that category. However, as the following examples illustrate, the quantity of outputs produced can vary significantly from one type of output to another within the same category – in this case, the *publications* category.

Example 3: Journal articles — **Scale**: *Number of articles per year*

Scale	<10	10-20	21-30	31-40	>40

Example 4: Books — **Scale** : *Number of books per year*

Scale	<3	4-6	7-9	10-12	>12

Step 4: Define criteria for weighting. To ensure that an organisation's objectives are taken into consideration during the scoring procedure, weighting factors should be applied to each output category. Relative weights can be based on different criteria – such as relevance for key target groups, contribution to national development goals, or contribution to advances in science – depending on the mandate of the organisation and nature of the outputs in each category.

Caution must be exercised in defining weights. It is important that they be based on appropriate criteria – i.e., criteria should reflect national development goals and/or institutional priorities, as opposed to individual perceptions or biases. The criteria and weights established by the assessment team need to be reviewed and approved by the organisation's management and should also be communicated to all staff.

Table 28.2 shows selected examples of weights that can be used in the OPAS. In the first example, technology outputs (Output category 1 in Table 28.2) that are relevant and accessible to producers are given more importance than those used for research or other purposes. Management practices (Output category 2) are weighted in favor of recommendations that benefit resource-poor farmers, while publications/reports (Output category 5) give most weight to published scientific works.

The numerical value assigned to each weight can range from "1-to-3", as indicated in the table. A "1-3-5" scale has occasionally been used to widen the spread of scores. Either scale can be used, so long as the organisation remains consistent in its choice.

Table 28.2: Examples of weights applied to output categories

Output category	Weights
Production and research technologies	potential impact on producers = 3 potential impact on research = 2 other = 1
Crop/livestock-management practices	more useful for resource-poor farmers = 3 more useful to commercial producers = 2 others = 1
Training events	farmer and extension training = 3 researcher-training = 2 other = 1
Dissemination events	participation of producers/farmers = 3 research/extension users = 2 other users = 1
Publications and reports	scientific journals/books = 3 farmer/extension materials = 2 other = 1
Public services	high coverage of producers in the country = 3 moderate coverage = 2 low coverage = 1

Step 5: Prepare output data sheets. Datasheets are essential for data capture but can also be used for data processing and analysis if prepared in a spreadsheet program, such as Microsoft Excel. The advantage of using spreadsheets is that the scores and ratios are computed automatically. The added feature of being able to generate various types of graphs to present and compare results over time and across categories (see Step 8) is also very useful.

A separate data sheet should be prepared for each output category. An example of a data sheet prepared for the *publications* category is presented in Figure 28.3. It incorporates the four elements needed to measure output productivity: scoring scales (as defined in Step 3), weighting factors (as defined in Step 4), raw data (Step 6), and formulae to make the necessary computations (Step 7).

Step 6: Collect and enter output data. Output-data[6] collection can be a time-consuming process. This is an important consideration when deciding the number of years to be covered in the analysis. Usually a five-year period is used when OPAS is implemented for the first time. Extending the assessment period is possible, but requires more time for data collection and entry.

A potential problem that can arise in this step is the absence of data for certain types of outputs identified. Data availability is usually weakest in the areas of dissemination, production, and service-related activities that often fall outside an agricultural research organisation's core mandate (ISNAR 2001). Difficulties in retrieving such information may be linked to organisational weaknesses, such as the absence of formal record-keeping systems, poor communications between organisational units and/or between headquarters and field staff, and loss of records due to staff departures. While it may not be possible to collect quantitative data for all outputs identified in the datasheets, awareness of such problems can motivate organisations to take decisions about the types of records that should be kept and ways to improve their record keeping. It is important that all data reporting be supported by documents or records (written or electronic).

Step 7: Compute productivity ratios. As mentioned earlier in this section, productivity ratios can be used as a basis for comparing output performance over time. These ratios are achieved through a series of calculations, which can be summarised as follows:

1. A yearly *weighted score* is produced for each output type (e.g., *journal articles*) by multiplying weight by score, as defined.

[6] *Output data* refers to the number of individual outputs produced, for each type of output identified in each category, during the assessment period.

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Figure 28.3: Example of an output data sheet in Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Ouput Category : PUBLICATIONS																
2																	
3	Type of Publications	Weight *	1997			1998			1999			2000			2001		
4			No.	Score	Weighted score	No.	Score	Wgted. score	No.	Score	Wgted. score	No.	Score	Wgted. score	No.	Score	Wgted. score
5																	
6	1. Journal articles	3	9	1	3	→ =(B6*D6)											
7	2. Research reports	3	11	2	6												
8	3. Technical reports	3	12	2	6												
9	4. Conf. proceedings	3	4	1	3												
10	5. Advisory leaflets	2	21	3	6												
11	6. Newsletters	2	40	4	8												
12	7. Books	3	3	1	3												
13	8. Training manuals	2	2	1	2												
14	9. Statistical surveys	3	3	1	3												
15	10. Maps	3	5	2	6												
16	11. Scientific databases	1	1	1	1												
17	12. Posters	1	8	3	3												
18	13. Consultancy reports	1	10	4	4												
19		Total output score :			54	→ =SUM(E6:E18)											
20		Productivity Ratio :			0.23			0.23			0.25			0.22			0.31
21																	
22					→ =(E19/x*)												
23					*researcher time (in this case, 230 researcher months/year)												
24																	
25																	
26		Benchmark :			0.248	→ =AVERAGE(E20,H20,K20,N20,Q20)											
27																	
28																	
29	Scoring Scales :				Number (no.) per year												
30		- scale for outputs 1-6 :			0	1-10	11-20	21-30	>30								
31																	
32		- scale for outputs 7-13 :			0	1-3	4-6	7-9	>9								
33				*Score :*	*0*	*1*	*2*	*3*	*4*								
34																	
35																	
36	* Criteria for Weighting : scientific publications = 3; farmer/extension materials = 2; other = 1																
37																	

2. A *total output score* is produced for each year assessed, which reflects the weighted sum of all outputs in that category in a given year.
3. The total scores are then divided by scientist time to yield yearly *productivity ratios*. These are useful for highlighting year-to-year changes in output production over the assessment period.
4. To allow performance comparisons in the future, a *benchmark* can be established for each output category. Benchmarks serve as points of reference for future assessments, and are achieved by simply averaging the productivity ratios of a given category.

These calculations can be generated automatically if proper formulae are incorporated in the data sheets (see Step 5).

Output analysis and follow-up

Productivity ratios will be of limited use to organisation managers unless they are supplemented by an analysis of the results. Increases or decreases in output production can be caused by a number of factors, such as levels of funding or shifts in program content. By examining these factors, certain output patterns and trends can be clarified.

An awareness of the "bigger picture" is essential if managers are to take appropriate action. It is important, therefore, that the results are also critically examined in relation to the organisation's mandate, to the needs and expectations of its clients and stakeholders, and to the policy and development objectives of government. The steps of output analysis are discussed in detail below.

Step 8: Analyse output trends and patterns. Information is often easier to understand and analyse when presented in the form of a graph. The use of line graphs is suggested to show output patterns and trends. This allows managers and others to see at a glance whether productivity in a given output category has fallen or increased, and how performance trends compare from one category to another (or from one assessment to the next, if the OPAS is carried out periodically).

Examples of line graphs are presented in Figure 28.4 to Figure 28.7. The four graphs show the same basic information, presented differently to facilitate different types of analysis. In all graphs the horizontal (x) axis shows the time period of the assessment – in this case ten years.

Figure 28.4 graphically presents the total weighted scores from the output analysis. The points on the graph correspond to actual results in the completed datasheets, allowing the year-to-year fluctuations within a given category to be analysed – for instance, why did dissemination events peak in 1999? Considerable year-to-year variations in output productivity may be expected at research institutes, making patterns and trends hard to observe. To facilitate the analysis of longer-term trends in output productivity, Figure 28.5 presents the same basic information, using three-year moving averages[7]. This has the effect of suppressing year-to-year fluctuations and smoothing the curves, making it easier for trends to be analysed – for instance, why is there a long-term decline in production of technology outputs?

Both Figure 28.4 and Figure 28.5 show the *absolute value* of output scores. Since the actual quantity of outputs can vary substantially from one output category to another, the absolute values cannot be compared across categories. In other words, if in a given year the output score for technology production is 20 and for dissemination 40, it cannot be concluded that the organisation is twice as productive in the dissemination category. To address this issue, the assessment team may choose to present the same information in index form. In Figure 28.6 and Figure 28.7, all output scores in the base year are set to 100, with subsequent growth or decline in output productivity related to that base year. As in the previous two cases, Figure 28.6 is based on actual output levels and is best used for analysing year-to-year changes, while Figure 28.7 is based on moving averages and is best used for analysing changes over time.

[7] In a three-year moving average, the 1995 score, for example, is replaced by the average of the 1994, 1995, and 1996 scores.

Figure 28.4: Output trends (actual scores)

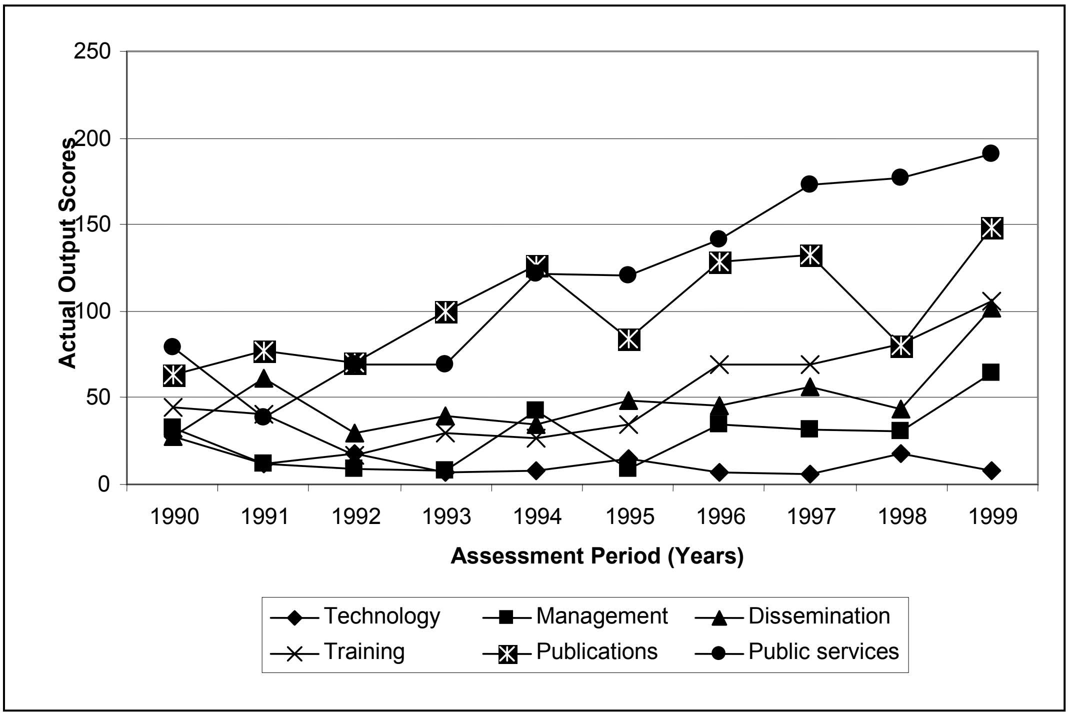


Figure 28.5: Output trends (three-year moving average)

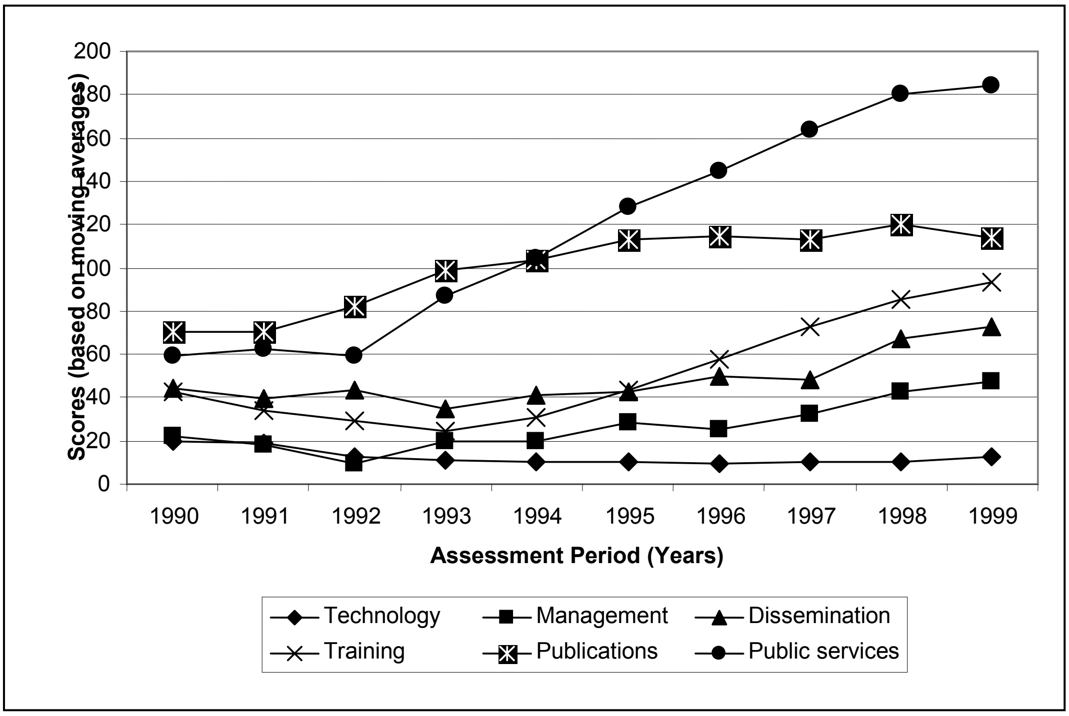


Figure 28.6: Output trends (1990=100)

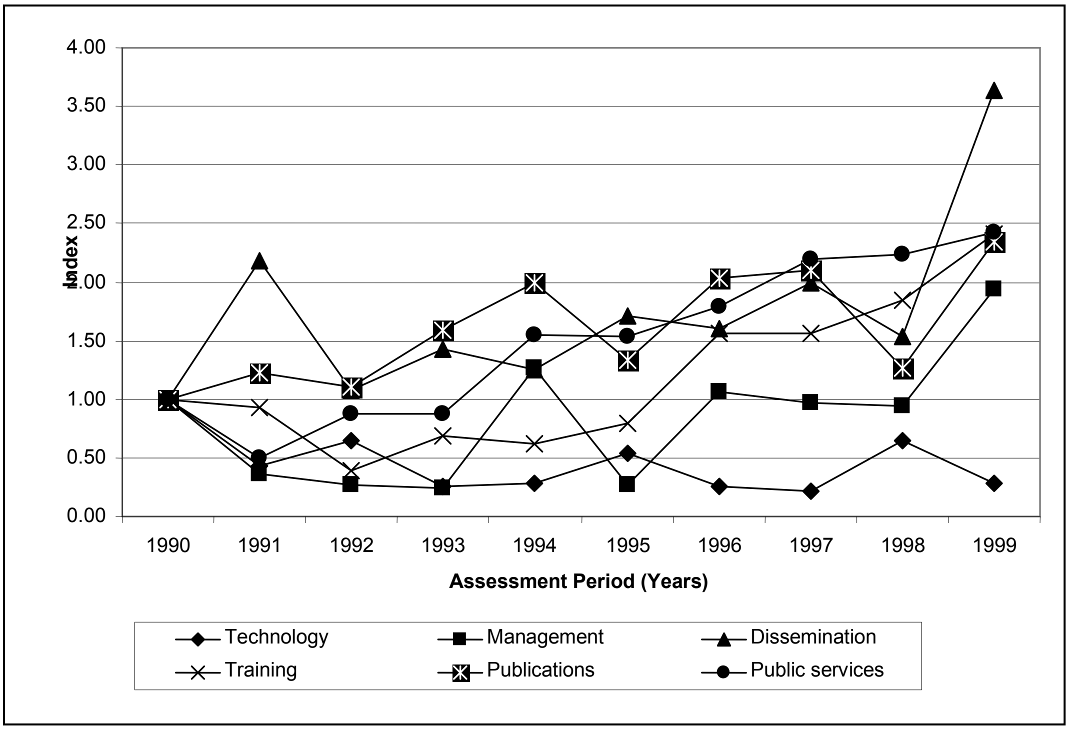


Figure 28.7: Output trends (1990=100, three-year moving average)

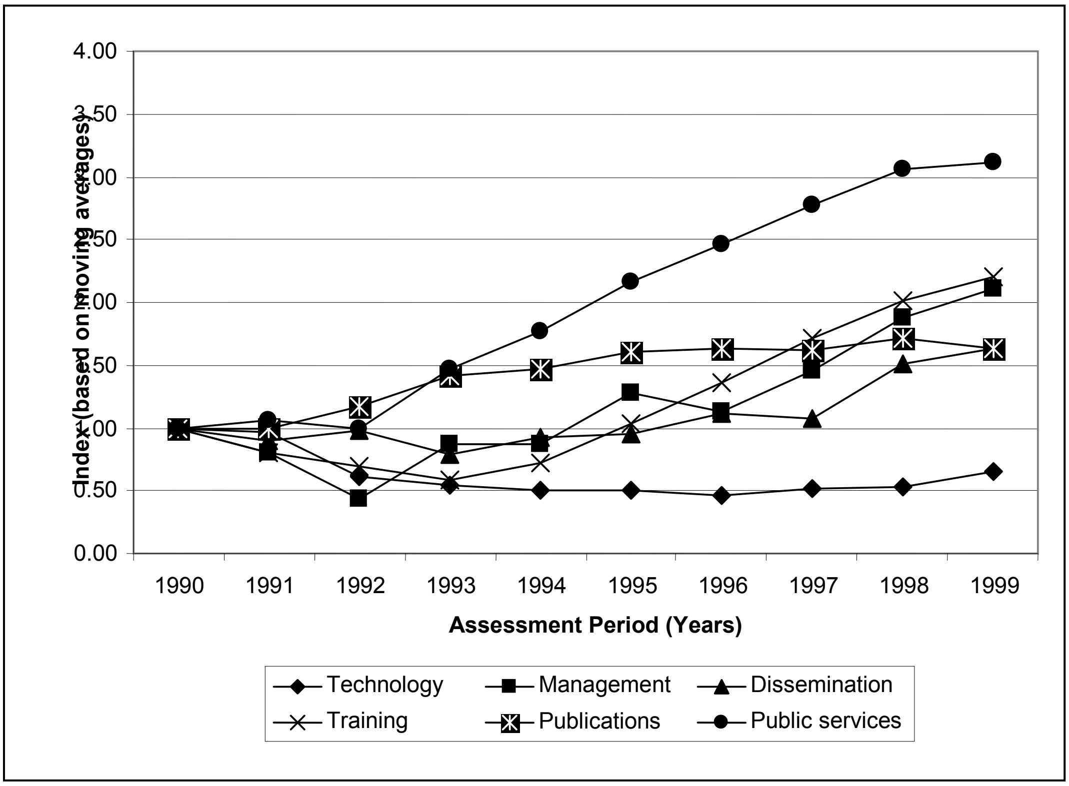


Figure 28.4 to Figure 28.7, as presented in this example, in general show increasing productivity, with the exception of *technology outputs*, a measure that shows an overall moderate decline. Strong output growth can be observed in *public-service outputs, training*, and *management practices*. More moderate increases can be observed for *publications* and *dissemination events*.

Describing output patterns and trends is not sufficient: they need to be explained. Managers need to ask themselves why certain outputs have increased and others have decreased, and what this means for the organisation in the short and longer term. For example, a decline in outputs could be linked to a loss of scientific staff. If, for instance, the scientists in question were sent for postgraduate training as part of a donor project, the loss would be temporary and represent an investment for the organisation – provided that the scientists do indeed return after completing their course. On the other hand, a sudden and sharp fall in outputs could affect investor and client confidence, in which case managers may need to inform their investors and clients, and may also wish to recruit additional scientists or hire temporary technical assistance in order to maintain or restore a certain level of outputs.

Step 9: Link to mandate and government objectives. Output patterns and trends, as discussed above, should also be examined in relation to the stated policy and development objectives of government to determine the extent of correspondence. This is especially important for public-sector organisations that are established by government and charged with the responsibility of addressing the needs of society in general.

Although the outputs of an organisation normally evolve over time, the development objectives for which the organisation was created need to be kept in mind, as a means of assuring sustained effort toward these ends and a focus on appropriate clients. On the other hand, government policies and goals are also subject to changes, and the organisation should be able to respond with appropriate shifts in outputs.

For these reasons, recent government-policy documents that affect the organisation should be reviewed against the kinds of outputs identified in the assessment process. If substantial deviations from policy appear, the organisation may need to rethink its output configuration.

An organisation’s mandates and statutes also need to be considered in the analysis of output assessment results. Application of the OPAS to organisations in several national systems has indicated variance between the outputs suggested by existing mandates and statutes, and the outputs actually produced. For example, some organisations mandated to carry out applied agricultural research have invested too many resources in publication outputs as compared with on-farm trials. Others with a mandate that includes basic research have, on the other hand, invested too little in the publication of their scientific findings.

While mandates and statute documents are important reference guides, organisations may also need to respond to changes in user needs and adjust to scientific advances. OPAS implementation has shown that, in each organisation assessed to date, a marked increase in various types of public service has occurred over the past five to ten years. Examination of this phenomenon suggests that one reason for the increase is that such organisations are becoming more responsive to the needs of farmers and other clients. Since mandates and statutes are difficult to change due to approval and legal processes, public-sector organisations in particular need to maintain a degree of flexibility, as do parent ministries and national-system-level managers. In sum, the mandates and statutes of an organisation should be reviewed during the output assessment process. This review can serve to inform managers about the need to reach agreement with their parent ministry about output configurations and, in extreme instances, about the need to initiate revision of mandate and statutes.

Step 10: Prepare report and recommendations. The final step of output assessment involves writing up the assessment results and analysis, defining recommendations for action, discussing these with management, and developing an action plan. The importance of the action plan is discussed in section 1.3. In a nutshell, an action plan encourages managers to come up with solutions. Measures needed to improve output performance are outlined in the plan, in the form of decisions to be taken by management that are based on the OPAS team recommendations and subsequent discussions. Implementation responsibilities and target dates should also be specified, for use in monitoring progress.

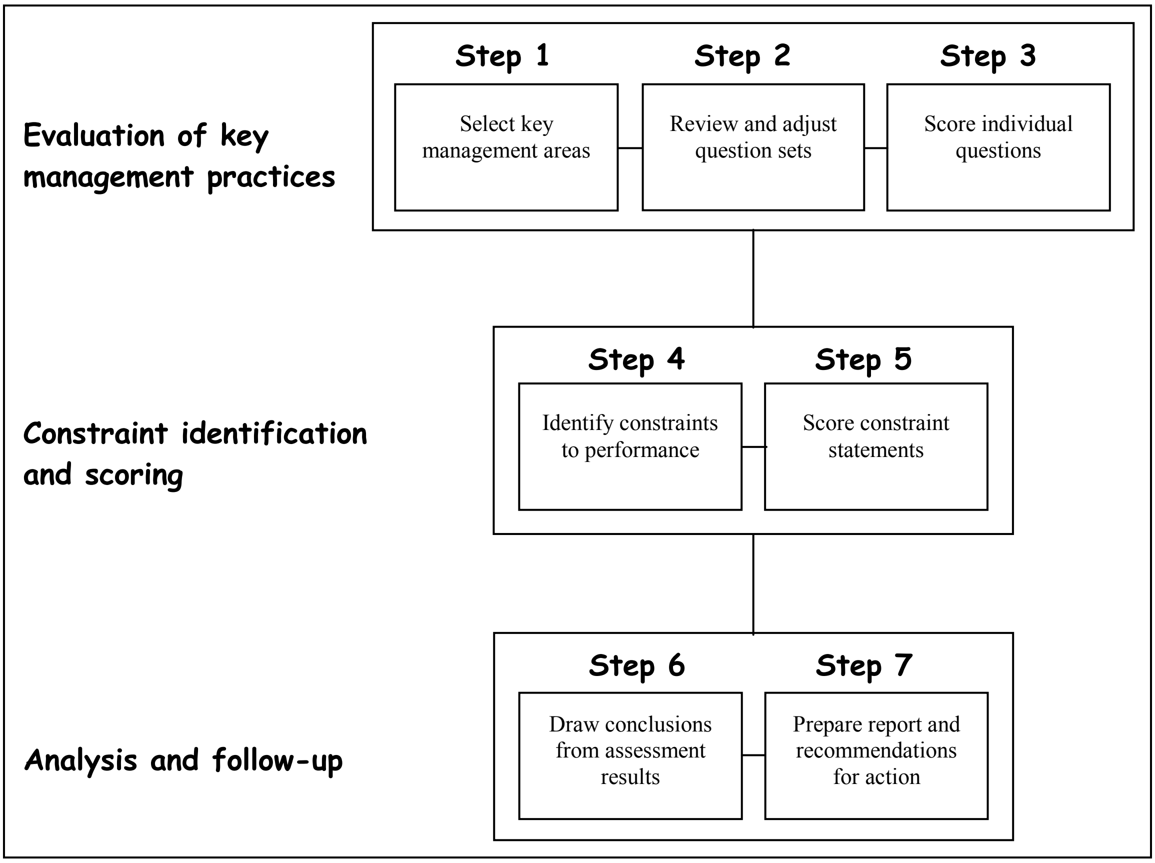
Management assessment methods

The ability of an organisation to produce useful and relevant outputs largely depends on internal policies, strategies, and management practices – and the context in which these are applied. By examining and evaluating these critical aspects of an organisation, managers can identify problems and constraints that are contributing to poor performance and, more important, take action to address them.

The methodology used in the OPAS to assess management-related issues[8] consists of seven basic steps, as indicated in Figure 28.8. The result is a rapid but thorough analysis of management strengths, weaknesses, and constraints. A team of staff knowledgeable about management practices should carry out the assessment.

[8] This methodology is adapted from concepts presented in Mosher (1985), Moynagh (1993), Faucett and Kleiner (1994), and Szakonyi (1994a and 1994b).

Figure 28.8: Management assessment methods used in the OPAS



Evaluation of key management practices

Step 1: Select key management areas. The OPAS establishes 10 key management areas that drive the performance of agricultural research organisations. A brief characterisation of each component area is presented in Table 28.3.

This selection of management areas is well founded and widely accepted as valid,[9] but can be modified to accommodate special conditions or needs. The first step of management assessment is to examine the recommended areas in relation to the target organisation and agree on a final selection.

[9] The management areas that appear in table 2.3 were selected on the basis of (1) a review of lists used by government-audit agencies and private corporations, (2) ISNAR experience in the field of agricultural research management, and (3) feedback from national managers during field-testing of the OPASwith equal importance attached to each area (ISNAR 2001).

Table 28.3: Management areas of OPAS

Management area	Importance
Assessing context and organisational responsiveness	Factors in an organisation's external environment (such as changing producer and industry needs, government policies, and market conditions) need to be understood in order to plan and produce outputs that are relevant and useful, and to respond effectively to current challenges and opportunities.
Planning the organisation's strategy	Any organisation needs periodically to review and adjust its directions and goals. *Strategic planning*, defined as "a disciplinary effort to produce fundamental decisions and actions that shape and guide what an organisation is, what it does, and why it does it" (Bryson 1995), provides a means of repositioning the organisation in its environment.
Defining the organisation's program objectives and priorities	At the program level, objectives need to be defined that are consistent with the overall strategy of the organisation and translated into feasible priorities that reflect user needs and development goals.
Planning research projects	Projects are the building blocks of an organisation's programs. As such, they need to be well planned in terms of their objectives, expected outputs, activities, and input requirements.
Managing projects and maintaining research quality	Responsible project management and practices for quality assurance and improvement are needed to ensure effective research operations, quality of output, and achievement of objectives.
Ensuring quality and quantity of scientific, management, and technical staff	Adequate numbers of well-qualified staff and effective management of human resources are key determinants of organisational performance. Relevant essential processes (in particular, staff planning, recruitment, evaluation, and training) need to be in place and properly executed.
Protecting the organisation's assets	Staff, funds, infrastructure, facilities, equipment, knowledge, technologies developed, intellectual property, and organisational credibility and reputation are the basis for sustainable delivery of research and service outputs. Continuous effort and attention are needed to protect these assets.
Coordinating and integrating internal functions, units, and activities	Overall structure (as reflected on an organisational chart) and organisation (including aspects such as information flows, governance, and terms of reference) need to be reviewed from time to time to ensure organisational coherence and the smooth and efficient running of operations. This management area is often neglected and, as a result, is the cause of many performance problems.
Managing dissemination and partnerships	A fundamental requirement of research organisation management is the dissemination of technology and information to users. Linking up with other actors in the agricultural knowledge and information system (extension, farmer organisations, universities, private sector, international research, etc.) also promotes information exchange, collaboration and cost sharing, and ultimately improves the quality and relevance of research.
Ensuring effective monitoring, evaluation, and reporting	Public-research organisations are under increasing pressure to account for their actions, use of resources, and results. Monitoring, evaluation, and reporting procedures need to be properly designed (i.e., integrated into project planning and implementation) and periodically reviewed in order to provide useful information for decision making and accountability.

Step 2: Review and adjust question sets. Each management area consists of processes and procedures that help keep an organisation running; it is these that need to be assessed for effectiveness. In the OPAS, analytical questions are used to determine the extent to which such practices are being implemented and benefiting the organisation.

To assist managers in this step, a basic set of questions is provided for each management area (see annex 3)[10]. These questions need to be examined and adjusted so that they are appropriate for the organisation. One of these sets is presented in Table 28.4. It shows the type of questions to be asked in evaluating management area 6, which is about *ensuring quality and quantity of staff.*

[10] The question sets are intended as a guide and incorporate 'best practices' related to management. Although they cover aspects of management that are common to most agricultural research organizations, not all questions are necessarily applicable to every organization. By the same token, some important questions may be missing from the lists. Each set should be critically examined and adapted to the characteristics and conditions of the organization being evaluated.

Table 28.4: Sample question set for assessing management performance

Management Area 6: Ensuring quality and quantity of scientific, management, and technical staff
1. To what extent does the organisation maintain and update staff information (e.g. biodata, publications, projects)?
2. To what extent does the organisation plan and update its staffing, recruitment, and training requirements?
3. How effectively are staffing, recruitment, and training plans linked to program and project needs?
4. How effective are selection procedures (for management, scientific, and support posts) in terms of objectivity and transparency?
5. To what extent is training based on merit and on organisation and program objectives?
6. How effective are mechanisms to promote a good working environment and high staff morale?
7. How effective is the performance-evaluation process for research staff?
8. How effective is the performance-evaluation process for non-research (management, administrative, and support) staff?
9. How effective are reward and sanction processes, in terms of motivating staff?
10. How effectively does the organisation compete with the private sector in providing salaries and benefits that attract and retain quality staff?

Step 3: Score individual questions. All questions that have been discussed and agreed upon in the previous step need to be scored. A four-point scale (0–3) is used to measure the degree to which each question is recognised or addressed by managers in the organisation.

The scale can be defined in different ways, depending on how the question is phrased. Two sets of answers are provided in Table 28.5. Set 1 has to do with the *level of implementation* of a particular practice in the organisation. Occasionally, a question will call for an opinion on the *effectiveness* of a given procedure or mechanism, in which case Set 2 is more appropriate.

Table 28.5: Management practive scales used in the OPAS

Set 1	**Set 2**
0 = not used or realised	0 = ineffective
1 = used or realised partially/ occasionally/ experimentally	1 = moderately effective
2 = routinely used or realised	2 = efforts made toward improvement
3 = continuous improvements under way	3 = very effective

The point scale usually works well, although semantic problems can sometimes cause misunderstanding. For example, the difference between “routinely used” and “continuous improvements” (in Set 1) may not always be clear to those undertaking the assessment[11]. Misunderstandings are usually caused by inexperience or inadequate explanation, underlining why it is important to involve experienced managers and staff, and a facilitator familiar with the methodology, in the evaluation process (see section 1.3.1).

Table 28.6 shows a set of questions that have been scored. The procedure is simple: scores for individual questions are established by discussion and consensus, or by averaging individual respondent scores for each question. These are summed to yield a *total score*, which is then divided by the total potential score (number of questions × 3) to produce a *ratio* for each key management area. Low scores indicate weaknesses or problems within the component area, either as a result of internal management or as a result of external factors.

As with output assessment, ratios provide a means of comparing performance over time. Initial results can be used as a benchmark for future assessments. Another advantage of using ratios is that the number of questions can vary from one component area to the next, without affecting the results.

[11] A practice may be routinely carried out, but fail to take advantage of certain methodological advances. ‘Continuous improvements’ implies that qualitative strides are being made in a given area.

Table 28.6: Sample questions set with scores

Questions for management area 6: Ensuring quality and quantity of staff Experience level	**(score 0-3)[12]**
1. To what extent does the organisation maintain and update staff information (e.g. biodata, publications, projects)?	3 (Set 1)
2. To what extent does the organisation plan and update its staffing, recruitment, and training requirements?	2 (Set 1)
3. How effectively are staffing, recruitment, and training plans linked to program and project needs?	1 (Set 2)
4. How effective are selection procedures in terms of objectivity and transparency?	2 (Set 2)
5. How effectively is training based on merit and the organisation or program's objectives?	1 (Set 2)
6. How effective are mechanisms to promote a good working environment and high staff morale?	2 (Set 2)
7. How effective is the performance-evaluation process for research staff?	2 (Set 2)
8. How effective is the performance-evaluation process for nonresearch staff?	1 (Set 2)
9. How effective are reward and sanction processes, in terms of motivating staff?	1 (Set 2)
10. How effectively does the organisation compete with the private sector in providing salaries and benefits that attract and retain quality staff?	0 (Set 2)
Total Score:	15
Management Performance Ratio (15/30) :	0.5

It is important to avoid biased scoring, as this will prejudice the results of the assessment. Staff may sometimes be reluctant to assess management, for fear of offending or even being punished. Managers themselves are not always willing to confront the weaknesses of their organisation. But since the assessment is intended to *guide* management in areas that require strengthening, managers and staff alike must recognise that distortions of this kind are self-defeating. OPAS facilitators and team members should question individual scores if they feel that a misunderstanding or deliberate bias is affecting the results.

Constraint identification and weighting

Step 4: Identify constraints to performance. After scoring the questions in each management area, the team can identify constraints to performance. Constraints are situations, often beyond the control of the organisation's managers that prevent the organisation from achieving its full potential. Weak performance in a management area is often related to the presence of significant constraints.

Constraints that commonly confront public agricultural research organisations include insufficient funds for research operations, inadequate levels of pay and benefits for staff, and excessive government bureaucracy. Organisation managers can and should respond by making higher authorities (for instance in the Ministry of Agriculture or the Ministry of Finance) aware of the effects and providing recommendations for improvement. A simple but effective way of identifying constraints is to rephrase those questions that received a low score in Step 3 and that relate to external forces.

Step 5: Score constraint statements. Not all constraints are equally important, which is why it is necessary to assess them separately. In this step, relative weights are determined, using a 1–4 scale for significance or urgency:

4 = very strong
3 = strong
2 = moderate
1 = weak

Table 28.7 includes constraints that have often been identified in relation to human resource management issues. A *constraint ratio* is determined for each management area by summing the intermediary scores and dividing the total by the maximum number of points possible. Ratios indicate the extent to which certain procedures and activities are affected by external constraints, and provide a basis for management action (see Step 7).

[12] The scale set that fits each question best is indicated in parentheses next to the score.

Table 28.7: Examples of constraint statements

Possible constraints related to management area 6: Ensuring quality and quantity of staff	Urgency (score 1–4)
1. Noncompetitive levels of pay and benefits	
2. Dependence on external funding for degree and short-course training	3
3. Outdated civil-service procedures for evaluating and promoting staff	3
4. Delays in filling vacant posts, due to bureaucratic external procedures	2
Total Score:	11
Constraint Ratio (11/16):	0.68

Management performance analysis and follow-up

Step 6: Analyse assessment results. In this step, the management performance results are analysed. An overview of the results (see example in Table 28.8) is useful because having all the scores and ratios in one place makes it easier to compare performance and constraint levels across the different management areas, and to reach some basic conclusions. The figures entered in the overview table should constitute the results of Steps 3 and 5, as the numbers in the shaded row illustrate[13].

Table 28.8: Management performance overview

Key Management Area	Performance Summary					
	Performance score	*Potential Score**	*Performance ratio*	*Constraint score*	*Potential Score***	*Constraint ratio*
1. Assessing the organisation's context and responsiveness	16	30	0.53	10	16	0.62
2. Planning the organisation's strategy	14	30	0.46	8	12	0.66
3. Defining program objectives and priorities	19	30	0.63	10	12	0.83
4. Planning research projects	26	30	0.86	2	4	0.50
5. Managing projects and maintaining research quality	15	27	0.55	9	12	0.75
6. Ensuring staff quality and quantity	15	30	0.50	11	16	0.68
7. Protecting assets	24	30	0.80	3	8	0.37
8. Coordinating internal function, units, and activities	13	33	0.39	9	16	0.56
9. Managing dissemination and partnerships	11	33	0.33	17	20	0.85
10. Monitoring, evaluation, and reporting	21	33	0.63	7	12	0.58

* Number of questions identified (subject to variation) × the highest score (3)

** Number of constraints identified (subject to variation) × the highest score (4)

The assessment team can determine different categories of management performance by clustering the performance ratios. The advantage of having categories is that it simplifies the analysis. Low, moderate, and high performance groupings are commonly used. These are based on ranges of performance ratios obtained in the assessment. For example, the ranges for ratios appearing in Table 28.8 could be established as follows:

0.80–0.86 = high performance
0.50–0.63 = moderate performance
0.33–0.46 = low performance

Using the example provided, one could conclude that the overall management performance of the organisation is "moderate" because most of the performance ratios appear in the moderate range. Similarly, one could conclude that the greatest need for management improvement is in the areas of *dissemination and partnerships* (Key management area 9) and *coordination of internal functions and activities* (Key management area 8).

An analysis of management areas in the high-performance range can be useful, both as a reference for managers and for reporting purposes, particularly if it indicates those steps previously taken that were successful in improving methods or procedures. More important to analyse, however, are the low scores or ratios, since they indicate areas of persistent management weakness or those affected by continuing constraints.

[13] The highlighted numbers in table 2.8 are drawn from examples given in the previous steps (see tables 2.6 and 2.7).

The assessment team should interpret the effect(s) that each constraint has on the organisation and the potential implications of maintaining the status quo. This information can then be used, in the next step, to develop recommendations for action.

Step 7: Prepare report and recommendations. Two immediate outcomes should result from the analysis: 1) recommendations to organisation managers on how to address *internal* weaknesses, and 2) recommendations to *external* decision makers. The latter deals with issues that affect the organisation, but cannot be addressed internally, such as the need for additional resources or policy changes. Building awareness at higher levels is especially important for public research organisations, given their dependence on external conditions and actions.

As with output assessment, it is very important to document the management assessment process, including the scoring results (and a record of how the scores were reached), the team's analysis of the results, its recommendations for improving research and management performance, and an action plan. The assessment report is a key source of information for managers, and should help guide future planning and decision making.

Planning, Implementing, and Using the OPAS

An organisational performance assessment can be planned and implemented in a number of ways, depending on the nature and size of the organisation undertaking the assessment, and the time and resources available. The fact that the OPAS emphasises internal evaluation and self-assessment, rather than external evaluation, has implications for how the process is organised – affecting, for instance, the extent of staff involvement, as well as the funding, time, information, and facilities required. Each of these implications is discussed in the sections below.

Planning and implementing the assessment

Who participates in the OPAS?

An OPAS exercise involves institute staff and one or two external facilitators. A team (or two teams) of professionals from the institution conducts the actual assessment and the institution's management needs to be involved at some stages. External facilitators are normally required to provide guidance and support to the assessment process. While the OPAS is essentially an internal process, external stakeholders can be invited to participate as observers.

The assessment team. As a self-assessment process, the OPAS relies heavily on the inputs of the organisation's own staff for the assessment and analysis. Before the exercise starts, a team should be formed that will be responsible for doing the work. Careful attention needs to be given to the tasks and roles of team members, as well as to the size and composition of the team.

The main tasks to be completed by the team involve output assessment, management assessment, and follow-up activities, which may include the presentation of results to management and institute staff, and the preparation of an action plan to address performance issues.

The size of the OPAS team is flexible, and will depend on a number of issues. Size, composition, and effectiveness are interrelated. A more complete representation of the different units and staff categories within an organisation will result in a larger team. However, in selecting the team, it is important to be aware of the trade-off between the benefits of working, on the one hand, with a small, relatively efficient, group and, on the other, with a group involving a broader cross-section of the institution's staff.

Depending on the size and structure of the organisation, the team should have between five and fifteen members. A smaller number does not provide a sufficiently wide range of perspectives, while a very large group becomes difficult to manage. However, these recommendations are flexible: for example, there have been cases of small organisations forming large teams to undertake the assessment because they wanted all staff to be involved.

Another consideration is whether to select a single team for the assessment or to involve two (sub)teams for different tasks. The availability of staff and facilitators, and time constraints are important considerations here. The advantage of a single team is that it becomes familiar with all aspects of the methodology. The OPAS has also been successfully implemented using separate teams for output assessment and management assessment. This helped to shorten considerably the duration of the exercise, but required the availability of two facilitators (one for each team) and frequent information exchange between the two teams.

Another option is to rely on a relatively small core team to implement the OPAS exercise, and to bring in additional expertise where needed. For example it may help to involve the head of the personnel department when assessing human resource issues. Care has to be taken, though, to ensure that the ad hoc involvement of such "outsiders" (who will often be senior members of staff) does not bias the results.

Criteria for selection of staff participating in the assessment relate to what skills they can contribute, what roles they play in the organisation (in terms of positions occupied or functions performed), and their interest in undertaking the assessment. The skills needed include a good analytical capacity, writing skills, and a good overall knowledge of the institution. Other factors to consider when building the team include balancing the representation of different programmatic units and disciplinary backgrounds, assuring representation of both research and administration staff, involving staff from both headquarters and substations, as well as taking into account age, seniority, and gender.

To facilitate the collection of output data it is important that the main internal units of an organisation are represented on the team. This allows easy contact with individual staff who will be called upon to provide information on those output categories for which data is not readily available (such as public-service outputs).

Where applicable, care should be taken to involve both staff from an organisation's headquarters and from regional centers or substations. The two groups of staff are likely to have different perspectives, especially on management issues.

Managers. The OPAS methodology is based on the premise that performance evaluations are more likely to be accepted and used by organisations if the leadership (director, managers) is involved in the exercise. The organisation's management can play a key role in ensuring the success of the evaluation exercise by providing initiative, support, information, supervision, and follow-up. Each of these issues is discussed below.

Unless an organisation's management is involved in the original *initiative* to assess the performance of the institution, the assessment is unlikely to be successful. Reviewing the performance of the institution can be (incorrectly) perceived as exclusively reviewing the management of the institute. This may be threatening to the director and senior managers. It should be made very clear – not only to institute managers, but also to higher-level decision makers in, for example, the parent ministry or research council – that the OPAS is a tool for learning and improving performance, not for criticising individuals.

Throughout the process, management *support* is needed for successful completion of the assessment. Management will have to assign the team, nominate a team leader, establish contact with external facilitators, and ensure the availability of resources – staff, funds (also for travel), facilities, and equipment.

Management also needs to provide *information* as an input into the exercise. While data requirements for the OPAS are limited and most of the information needed is readily available, there are certain types of information that are best known to an organisation's managers. For example, they will be aware of the reasons behind certain policies, procedures, and practices that are followed by the organisation. Management may also need to provide background and context information to put things in perspective.

Supervision by management may be needed to keep the process on track and to ensure that targets and deadlines are met. Usually this is not a serious problem as the OPAS exercise can be completed within a relatively short period.

Management plays a key role in the *follow-up* to the assessment. Without follow-up, the assessment remains just that and steps toward improving performance are not made. A plan to improve performance that seeks to address the main weaknesses identified in the assessment is essential, but such a plan cannot be implemented without management commitment.

Management may or may not be involved in the actual implementation of the performance assessment, depending on specific circumstances and preferences. Advantages of managers being directly involved in the exercise include their gaining a good understanding of the methodology and an immediate buy-in. Potential disadvantages include the tendency of managers to dominate group discussions and so to bias results. Sometimes managers and senior staff are tempted to use the OPAS to "showcase" their institution to the outside world. It should be remembered, however, that the exercise will only be credible if it provides an honest assessment of both the strengths and weaknesses of the institution.

Facilitators. A performance-assessment exercise requires one or two facilitators. These facilitators may be from inside or outside the organisation, and would play different roles the first time the OPAS is implemented and on subsequent occasions.

It is advisable to use an external facilitator when the OPAS is applied for the first time in an organisation. The facilitator in this case would be a person with a thorough understanding of the methods, and with some experience of their implementation. The main tasks of the facilitator in the initial exercise would be to introduce and explain the methodology, in addition to guiding and moderating the process. As the concepts and methods become more familiar to the organisation with subsequent implementations, the facilitator will essentially be needed to guide and mediate group discussions, and ensure that the process is kept on track and completed within the agreed time period.

External facilitators should assist in the formation of the core team, ensuring that the criteria discussed above are taken into consideration. Adequate overall skills, balanced representation of organisational units, and the involvement of specific expertise are important concerns.

Substantively, there are two main facilitation tasks. The first is to assist the team in identifying outputs. While every organisation is unique, the six main output categories (presented in Table 28.1) usually provide an adequate framework to capture the range of outputs produced at all but the most specialised institutions. The team will need to identify all outputs produced, within those categories, develop scales for measuring output production, and define criteria to weight the outputs.

The more difficult facilitation task is related to the assessment of strengths and weaknesses in the ten key management areas. The requirements for this task provide a good idea of the qualifications required for facilitation in this area are:

- a good conceptual grasp of research management issues;
- the ability to introduce sometimes unfamiliar and complex management and governance concepts to the team;
- the ability to ensure that the team is neither too critical, nor too positive about the performance of the institute;
- the ability to ensure that one or a few outspoken individuals do not dominate the discussion.

Facilitators may also help in preparing the assessment report. While the task of writing report sections should be assigned to individual team members, the facilitator's help is often needed to complete the report, especially when an OPAS is done for the first time.

Internal evaluation is sometimes criticised for lacking objectivity and rigor. An important advantage of using external facilitation is that it helps to make the exercise more credible and objective. Organisations familiar with the OPAS methods and process may decide, for several reasons, to rely on internal facilitation. This is possible, provided the internal facilitator is highly respected within the organisation and has the necessary attributes described above.

Time requirements and scheduling of activities

An advantage of the OPAS is that the exercise can normally be completed within a relatively short time. The total time required for the OPAS exercise depends on the size and structure of the organisation. Output assessment takes more time for large organisations with many programs since information is often scattered over a number of sites or substations and may not be readily available at the headquarters – which is where the OPAS team would normally work. In large countries this may mean that information has to be collected through forms mailed, or visits made, to the stations. Obviously, more time is needed for data collection under these circumstances and it may be necessary to split the OPAS exercise into two stages. Time requirements for management assessment, on the other hand, will not vary much from one organisation to another.

In the scheduling of activities two decisions need to be made. The first is whether the OPAS will be completed as a single process, or in two or more stages. In situations where information is readily available, the OPAS exercise is best completed as a single intensive activity. But where information needs to be collected from remote stations the exercise may need to be split into two separate stages. The first would include the introduction of methods, identification of outputs, development of scales and scores, and identification of information collection needs. The second phase would begin once all the necessary information has been collected from different units of the organisation.

If more time is needed to collect data for output assessment it may be practical to proceed with the management assessment while the information is being collected and return to the output assessment after the data has come in.

The second decision is whether the OPAS will be carried out sequentially by a single team or whether separate teams will be involved in output and management assessment respectively. In most cases OPAS implementation has been the responsibility of one team. An option is to appoint two teams working in parallel fashion, one concentrating on output assessment, the other on management assessment. The main benefit of this arrangement is that it shortens the total duration of the exercise (though not the net time) considerably. But for this approach to work several conditions must be met:

- at least two facilitators are needed;
- a larger number of staff needs to be available to serve on the two teams;
- progress reports to both teams or frequent interaction between the two teams is needed to exchange information.

As can be seen from the previous paragraphs, there is no single best way to do an organisational performance assessment. One of the attractions of the OPAS is its flexibility with regard to implementation.

Financial requirements

Three types of costs can be incurred when doing organisational performance assessment: staff time, hiring of external facilitators, and operational costs.

Staff time: The OPAS team will require approximately two weeks for the exercise. The cost related to their involvement is normally not a direct expenditure item since staff are on the organisation's payroll. But there is an opportunity cost: time spent by staff doing the OPAS cannot be spent on other important activities, especially research. The management of the organisation will have to decide if the OPAS is of sufficiently high priority to free up a team of staff from other duties.

Facilitation: The cost of external facilitators can be the most important expenditure item. If national facilitators are available, the cost may be relatively low. If, on the other hand, external facilitators are brought in from abroad, the cost may be high for many developing-country organisations, unless special funding can be obtained from a donor. If the assessment system is to be successfully institutionalised, it will be important to develop a group of national facilitators who can continue to implement the OPAS process over the years.

Operational costs: These may include the cost of travel to stations (if necessary), travel allowances for team members not residing at headquarters, publication of reports, and possibly the cost of a workshop or seminar to present the results to senior decision makers and stakeholders. In practice, OPAS can, if necessary, be implemented at very little operational expense.

Information needs

The OPAS has been designed in such a way that it does not require extensive data collection; data on outputs is usually available at all institutions, either in written documents, files, or people's memory.

Written materials include research reports and administrative reports – such as policy documents, plan documents, annual reports, project documents, and reports to donors.

For the output analysis not all information may be readily available. While information on outputs related to institute core activities (such as new crop varieties and technologies) can usually be found in research reports or annual reports, there are usually other types of outputs for which information is not consistently collected. This relates especially to the types of service outputs that may or may not be part of the core mandate of the institution, but that are produced as a service to clients or the general public.

Organisations do not always keep track of the number and type of training events and dissemination events, or the number and type of public services provided (for instance soil analyses or artificial insemination), even though this kind of information may be important to funders and other stakeholders. If not available, this information can usually be collected without too much effort from the responsible heads of units, as records are usually kept for internal use. The institute may decide, as a result of conducting the OPAS, to collect this type of information on a more systematic basis in future as it provides important material for future assessments, as well as for annual reports, leaflets, and brochures that demonstrate the organisation's activities and achievements.

Information for the management-assessment component of the OPAS is "tacit" or implicit knowledge that resides in people's heads. The information is made explicit through group sessions that aim to reach a consensus on how well the institute is performing with regard to ten key management areas. The facilitator plays a key role in providing information on the respective management areas and related questions. This role is especially important for an OPAS team that largely consists of technical staff, who may be unfamiliar with management concepts.

Providing evidence and justification for the scores given is essential for the credibility of the self-assessment exercise. First, the exercise is aimed at improving management practices at the institution and will become pointless if the team does not take an honest look at strengths and weaknesses. Second, when outsiders read the review of strengths and weaknesses, they have to see a believable story that contains a balanced review of the institution.

Equipment and facilities

Requirements in this category are fairly simple. One or two meeting rooms are needed for the duration of the exercise. One or two personal computers with word processing and spreadsheet software will be needed for report preparation and tabulation. An overhead projector is important for presentations. If available, the use of a multimedia projector is highly recommended for the group sessions. It allows all participants to see directly how the discussions on outputs and management issues are summarised and provides an opportunity for instant feedback on both substance and wording.

Using the OPAS results

The results of an OPAS exercise can essentially be used in two ways. The first and main purpose of conducting an OPAS review is to contribute to improved performance in the production of organisational outputs and in a number of key management areas. A second important function of the OPAS is to improve accountability to funders and other stakeholders by providing information on an organisation's outputs and productivity on a systematic and regular basis.

Improving performance

It is often said that "what gets measured gets done." OPAS provides a comprehensive review of institute outputs and management issues that allows institute managers to act in specific ways.

Output assessment. Output assessment and analysis can help institutes to improve performance in three ways. First, it provides a comprehensive list of outputs produced, including those related to mandated core research and technology transfer tasks, as well as those produced as a service to the public that may not be explicit in the mandate of an organisation. By reviewing the list of outputs produced, managers may decide that some are no longer relevant and that their production should be stopped. Furthermore, a comparison with outputs produced by other institutions with a similar mandate may reveal gaps and differences that may lead managers to add new tasks and outputs to be produced.

OPAS provides an opportunity to weight some outputs of an organisation more heavily than others. A second way, therefore, in which output assessment results may be used to improve performance is to orient efforts more explicitly to those outputs that have received a higher weighting by the organisation. For instance, if the institute decides that farmer-oriented publications are more important than journal articles, even though production of the latter is consistently higher, this will reveal an obvious discrepancy that should be addressed.

The process of output assessment normally covers a period of five (sometimes ten) years. So, a third way of using OPAS information to improve performance is to observe trends in the production of institute outputs, analyse the reasons behind the changes, and take remedial action where necessary. For example, one institute that recently implemented the OPAS observed a decline in publications, which came as a surprise to management; this finding prompted a search for reasons and remedies.

Two points of caution need to be made with regard to output assessment. First, there is a downside to "what gets measured gets done." Performance indicators are a measurable but incomplete representation of underlying performance. The use of performance indicators (such as the number of publications in scientific journals) will orient behavior towards the indicators, especially if incentives (for example, staff promotions) are linked to those indicators. Generally speaking, this is desirable in order to focus activities on high priority areas. However, sometimes people may react in sophisticated ways towards performance measurement. If, for example, the number of research reports is a performance indicator, staff may respond by producing more reports that are shorter and of lower quality. Organisations may cope with this situation in various ways. It is especially important to select output scales and weights carefully. It is also important to be careful when linking indicator-based performance to incentives, rewards, and sanctions, particularly at the level of individuals. The emphasis should be on the use of the OPAS at the organisational level and as a collective learning instrument to improve the performance of the organisation as a whole.

A second point of caution is related to comparing the performance of one institution to that of others. While national-level managers sometimes express a desire for such a comparison, this should be approached with great caution. As all institutions are different, there are usually valid reasons to explain differences in outputs produced and productivity. Superficial comparison of output and productivity scores between institutions is likely to lead to misleading conclusions. OPAS was designed to support learning and improvement within a single institution.

Management assessment. Management assessment information can be used in several ways to improve organisational performance. The OPAS exercise identifies those areas where management performance is especially weak. In an exercise that has been well carried out, comments and ideas will have been collected on the main reasons for lack of performance in specific areas. If, for example, weaknesses in project management are identified, the logical next step is to look for variables that explain the low performance. It may be related to the fact that the notion of what constitutes a project is poorly understood within the organisation; or that the responsibilities for project management are not well defined; or that projects do not have adequate funding.

OPAS not only identifies weaknesses, but also strengths. The results may be used to document good-practice cases where the organisation would have given itself a score of 3, denoting *continuous*. An institute may, for example, have developed an innovative way of doing monitoring and evaluation. Such information may be relevant to convincing funders that the money awarded to the institution is well spent, while improved practices may also be emulated by other institutions.

The OPAS recognises that some, but not all, management issues can be adequately addressed at the level of the institution. An organisation's management should first act on those issues that are under its own authority. Usually, significant progress can be made here. Then there are issues that need action at higher levels, or by other actors in the research system. This is especially the case in centralised and bureaucratic public-sector systems. Effective lobbying for change requires information on exactly where the decision-making authority lies. If authority lies with a next higher level, such as a research coordination body, the chances of achieving change may be relatively good. On the other hand, if certain practices are based on national, civil service rules, there may be little chance for change in the short term.

Development of a performance action plan. The development of a concise plan, to address productivity problems in outputs and weaknesses in management areas, is a good instrument to set objectives and to monitor the implementation of the performance-improvement process. Such a plan can be a very simple list of improvements to be made, tasks and responsibilities assigned, and deadlines established. Or it can be a more comprehensive document that goes into more detail. Ideally, an action plan distinguishes between those issues that can be addressed in the short term, and those that require a longer-term effort. Similarly, the plan may indicate which issues are under the control of the organisation and which depend on action by other actors. The fact that a constraint is imposed from outside does not mean, however, that the institution is powerless. Awareness building and lobbying are needed to convince higher authorities of the need for change.

A performance action plan provides a vital reference for managers that can help them to focus on required actions. It also creates transparency within the organisation and communicates intentions both internally and externally. Table 28.9 presents an abbreviated example of an OPAS action plan, developed by an actual research institute.

Ensuring accountability

A key feature of accountability is the provision of timely and adequate information to internal and external stakeholders. Organisations used to be held accountable mainly for their *compliance* with administrative rules and procedures. Increasingly, however, research organisations are held accountable for their *performance* – the outputs and results that they produce with the resources entrusted to them. The OPAS may help to generate and present performance information for accountability to a variety of stakeholders.

The information generated may be used in special reports to donors and may be included in institutional publications such as annual reports. In summary the key points on which information can be provided to stakeholders relate to

- providing a full picture of the outputs produced at the institute;
- trends in output production and productivity;
- priorities for productivity improvements in line with the weights given to outputs;
- information on strengths in specific research-management areas;
- actions and strategies to address management weaknesses;
- recommendations to external decision makers on ways to address constraints to organisational performance.

Final observations

Performance-assessment systems are not often used in public-sector agricultural research organisations, primarily because of a lack of awareness of performance-evaluation approaches used by other public sector organisations and the dominance of donor-driven evaluation procedures and other external needs. There is also a lack of an evaluation and performance "culture" among such organisations. Other commonly encountered reasons include

- severe time constraints;
- resource constraints, particularly shortage of staff;
- the lack of relevant information and data sources;
- management's negative experiences and perceptions of evaluation.

Any approach to performance-oriented evaluation and management that is introduced should have an *internal management* perspective. Such approaches require the participation and guidance of managers. Other conditions for success include

- management interest or external pressure to initiate a performance-assessment system, and the commitment of managers to its development and use;
- identification of information sources and adequate staff assigned to implement the system, in particular to collect and use performance data;
- full involvement of the organisation's staff in adapting and establishing the system to suit the conditions and needs of the organisation;
- the integration of the assessment system into management processes and decision making.

The results of building a performance orientation into an organisation include better alignment of that organisation's efforts with government policies and goals, improved management and productivity, and an ability to report performance to others. An institution-building objective is also achieved by familiarising the management team thoroughly with the key areas of management activity, and the strengths and relative weaknesses of their organisation

Table 28.9: Performance Action Plan – Summary Example

Problem/constraint	Suggested action	Responsibility	Target Date
Poor participation and cooperation of end users in research activities; lack of stakeholder feedback mechanisms	Establish effective linkage and feedback mechanisms with key stakeholders	Board Chair, Director, Economics and Farming Systems Department	From January 2003 onwards
Inability to recover costs, or retain funds from income or revenue generating activities	Prepare policy recommendations for consideration at higher levels.	Board Chair, Director, Division Heads	Before January 2004
Poor levels of cooperation between support and operational units	Improve management practices related to the coordination / integration of internal units and functions	Director, Divisional Heads and Unit Heads	June 2002 onwards
Inadequate staff motivation and low morale	Develop a transparent system of appraisal to reward staff for better performance; should develop a benefit package comprising merit increments, sabbatical leave, training etc.	Ministry, Board, Director, Division Heads	Before January 2003
Inadequate fund availability for training of scientific staff	Develop a sound training plan taking into consideration the available and required expertise. Obtain Govt and donor support for training plan.	Director and Divisional Heads	For the 2003 budget
Insufficient staff, financial and capital resources for the implementation of priority research	Muster support of clients, stakeholder groups, and donors. Demonstrate research results more effectively.	Institute management with the help of research and extension staff	2003
Lack of a strategic plan that indicates future directions for the institute	Develop a strategic plan with the involvement of internal and external organisations	Institute team with ISNAR support	April 2002
Inadequate and ineffective monitoring, evaluation and reporting	Establish a small planning, evaluation and monitoring unit of specialists at the institute.	Director and Divisional Heads	June 2002
Lack of a proper financial information system	Develop management and financial information systems that include the information required for the management of research programs and projects.	Director, Board, Deputy Director Administration	Before December 2002

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PART V OTHER RELEVANT TOPICS

Part V of the Sourcebook is a collection of other relevant topics and methods available for inclusion in the tool kit of the reader. It follows therefore that there is no major coherence linking the various chapters together. The general context, however, is that there is a need to have special methods and approaches for special situations where the more widely adopted methods do not meet the need.

One challenge is assessing agricultural development projects and programs with multiple layers of objectives. Multi-Criteria Analysis as discussed in Chapter 29 can be appropriate for such need. The other situation concerns impact assessment of benefits and costs of natural resources and the environment. Chapter 34 discusses 'non-market' valuation approaches that can be useful in this situation. The Delphi Method in Chapter 32 is also a special purpose estimation approach for various situations.

The growing importance of participatory processes in agricultural development is also shown in Chapter 30. This Chapter is a comprehensive collection and discussion of various participatory approaches. The reader is encouraged to treasure and periodically refer to this Chapter because it is a rare collection of what is found generally in the literature. Chapter 31 is targeted at those scientists who would like to use their trial data for purposes of assessing economic and social impacts. This Chapter discusses such simple methods that non-economists can use and in this regard the reader, if a non-economist, should take advantage to familiarise oneself with these simple but effective evaluation tools. Adoption studies are discussed in Chapter 33 and the issue of adoption is key to the understanding of how research results lead to higher productivity of farmers and eventually lead to progress through greater food security and income generation by scientists and managers.

MULTI-CRITERIA ANALYSIS

Introduction

"Multi-criteria analysis" refers to a set of procedures designed to help decision makers choose between alternative plans and options in situations where there are multiple objectives. Decisions involving the use of natural resources frequently involve multiple objectives. Multi-criteria analysis has three main components:

- A finite number of alternative plans or options;
- A set of criteria by which the alternatives or options are to be judged; and
- A method for ranking the alternatives or options according to how well they satisfy the criteria.

The multi-criteria technique can take into account different points of view by varying the weight applied to each criterion. The major benefits of the technique are a more rational structuring of the decision-making process and better understanding of different options and the effects of divergent social values upon their evaluation. Both conservation and development aspects of alternative uses of natural resources can be captured in the analysis. Some of the aspects involved in conducting a multi-criteria analysis are discussed in this chapter.

The role of Multi-Criteria Analysis

Decisions are made every day at all levels, from the individual to the international. Some are straight forward and others are extremely complex, with the inherent need to integrate a large amount of factual information, (economic, strategic, social and environmental) with value judgements, public opinion and policy and management goals. The more complex the problem, the greater become the need to structure the decision-making process in a systematic way in order to improve both the quality of the decision and to justify any action taken. Multi-criteria analysis is one way of doing this.

All decision making incorporates subjective decisions that depend on the value systems and objectives of those involved. The aim of multi-criteria analysis, as with other decision support techniques, is to provide a framework, within which the effects of uncertainties and different values can be evaluated and explored, e.g., use of forest resources.

If we assume that there are three possible alternatives to use forest resources as follows:

- Allow unrestricted logging in all forests;
- Prevent logging in specified areas and permit intensive logging practices in the remaining areas; and
- Ban logging in all forests.

Criteria for judging these three alternatives are:

- Provision of employment;
- Preservation of the natural environment;
- Income from harvested timber;
- Soil erosion; and
- Opportunities for recreation and tourism.

Alternative:

1. Provides the greatest income from harvested timber. It may not satisfy preservation and recreation needs.
2. Provides best level of preservation and recreation but with undesirable social and economic consequences.
3. Compromise between 1 and 2 but has the highest level of environmental damage in terms of soil erosion.

Multi-criteria analysis compares the advantages and disadvantages of each option, one against the other and thereby assists decision makers in reaching a decision.

Using the available information one can construct an "effects table" or "effects matrix." An example of an effects table is presented in Table 29.1. The columns of the effects table represent the alternative plans or options and the rows represent the criteria by which the alternatives are to be evaluated. The entries in the effects table indicate how well each alternative scores with respect to each criterion. Some multi-criteria methods require scores to be measures quantitatively; that is, with numerical values. For others, qualitative scores such as ranks and pluses and minuses are sufficient. The ability of some multi-criteria methods to deal with qualitative scores or a mixture of quantitative and qualitative scores provides greater flexibility compared with techniques such as benefit-cost analysis that requires all values to be quantified.

Table 29.1: Example of an Effects Table

Criterion	ALTERNATIVE 1 Unrestricted Logging	ALTERNATIVE 2 No Logging in Some Areas, Intensive Logging in Others	ALTERNATIVE 3 Logging Banned
Employment (Number of Jobs)	53	45	5
Preservation (Qualitative Scale)	---	+	+++
Income ($'000 per Annum)	23	28	0
Soil Erosion (Relative to Alternative 3 in Kilograms per hectare per Year)	31	74	0
Tourist and Recreation (Ranking From Most to Least Desirable)	3	2	1

***Note**: Multi-criteria analysis is an approach rather than a single well-defined procedure.*

Multi-Criteria Analysis and Decision Making

There appears to be three ways in which multi-criteria analysis can contribute to decision making:

- It can provide a ranking of alternatives, allowing the decision maker to choose the "best" (highest ranked) alternative;
- It can help to structure the policy and planning process in a more rational way, by helping to define the information needs of a particular problem at an early stage, through a comprehensive consideration of criteria and alternatives, and by fastening a learning process in which decision makers and others can contribute to the analysis and refine the information needs as the multi-criteria analysis proceeds; and
- It can improve decision makers' understandings of different options and of the various ways in which the options may be evaluated. In particular, the effects of divergent social values upon the evaluation of different options can be highlighted through the use of multiple weighing sets or through the construction of ideal or extreme options, and questions concerning factual information can be distinguished more clearly from matters of social value.

The ability of multi-criteria analysis to deal with measurements on a variety of scales may provide an advantage over benefit-cost analysis in some situations. A multi-criteria analysis can obviate the need to employ methods such as contingent evaluation to place monetary values on non-market amenities for the purpose of benefit-cost analysis. Although multi-criteria analysis does not eliminate the difficulty of ultimately reducing all scores to comparable basis (through a combination of standardisation, weights and evaluation methods) it does provide more flexibility in exploring different ways of doing this, than is available with a strict economic analysis. Multi-criteria analysis should be regarded as an aid to the decision making process. It may be worth noting that the potential actions are not necessarily mutually exclusive, and their feasibility may be unknown.

Steps in Analysis

Specifying the alternatives or potential actions

The list may be reduced to a manageable set by eliminating those that do not satisfy an initial screening test.

Specifying criteria

Multi-criteria analysis is founded on the notion that decision makers usually attempt to satisfy more than one objective simultaneously. These objectives are likely to be quite general and involve concepts such as economic well-being, environmental quality and quality of life.

The label "criterion" covers a continuum from relatively well defined and easily measured quantities, such as area of land placed in conservation reserves, to less well defined concepts such as environmental quality. In specifying the criteria to be used in a multi-criteria analysis, compromises may be necessary between selecting criteria that are relatively easy to measure, but are only indirectly related to the objective (area of forest in conservation reserved and preservation of biodiversity), and selecting criteria that are difficult to measure (preservation value), but are more closely related to objectives. Criteria are subdivided into groups of sub-criteria and possibly into groups of sub-criteria. When a criterion consists of several sub-criteria, the process of evaluating the sub-criteria and deriving a score for the parent criterion can be regarded as a multi-criteria analysis of its own right.

Forest users may have three possible objectives:

- Maximise economic growth;
- Maximise environmental quality; and
- Maximise the quality of life.

The various sub-criteria that one could use in the analysis is presented in Figure 29.1. The number of criteria is also important. The "rule of thumb" is that the number of criteria within a group should not exceed 10 or 12. Janssen (1992) recommends no more than seven.

The criteria used in a multi-criteria analysis should be (Keeney & Raiffa, 1976):

- Complete. If two alternatives have the same score for each criterion then it must be agreed that the two alternatives are equivalent. In other words, there should not be any additional basis for distinguishing between alternatives;
- Operational. The set of criteria should be able to be used in some meaningful manner in the ensuring analysis; and
- Decomposable. It should be possible to simplify the analysis by desegregating the decision problem. In the extreme case in which the score for each criterion is dependent on the score for every other criterion, the multi-criteria structure is lost completely, e.g., criteria include biological diversity and the area of disturbed land:
    - Increases in biological diversity are considered desirable in natural areas; and
    - Increases in biological diversity are considered undesirable in disturbed areas, as they result in an invasion of weed species and pests.

  This set of criteria is not decomposable because biological diversity cannot be evaluated independently of the area of disturbed land:
- Non-redundant. No aspect of the problem is accounted for more than once; and
- Minimal - there should be no other smaller set of criteria satisfying the preceding conditions.

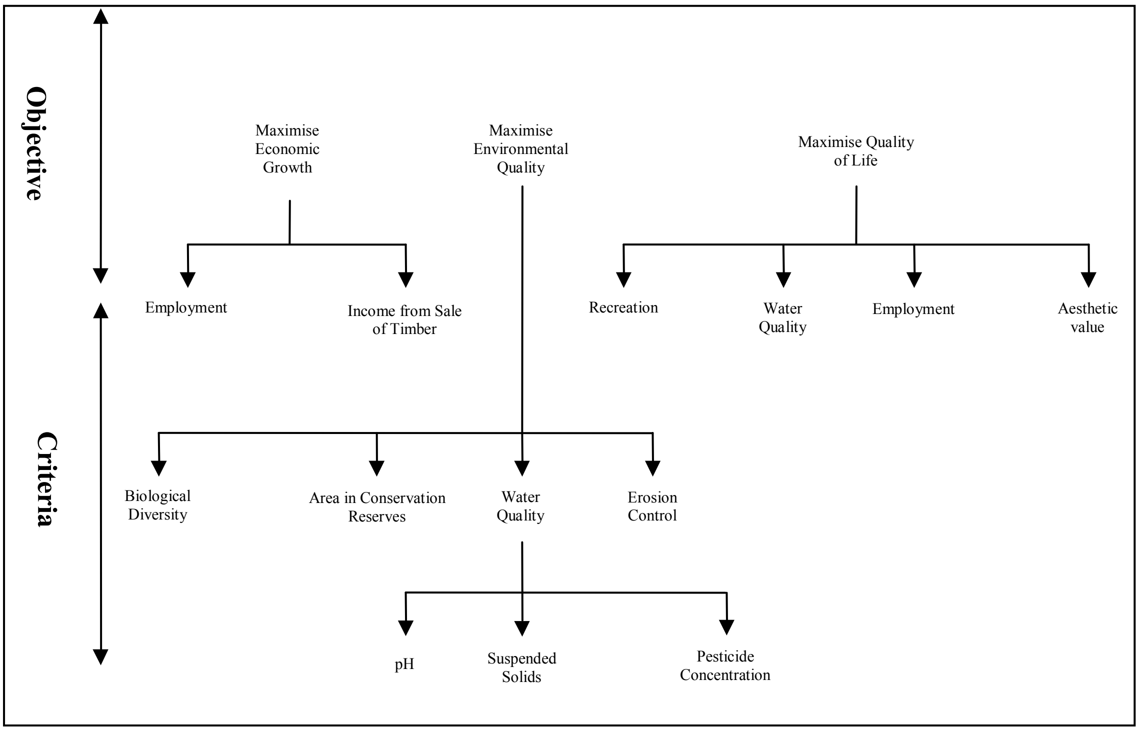

Figure 29.1: Hierarchical Arrangement of Criteria

Scoring alternatives in relation to each criterion

In order to complete the effects table, some value or score must be assigned to each alternative indicating its performance in relation to each criterion. There are three types of measurement scale: ordinal, interval and ratio.

Ordinal

Ordinal provides information in order, i.e., one alternative score's higher than another alternative but not how much.

Interval

An interval scale provides a measure of the difference between two alternatives, but does not indicate actual magnitude. For example, on an interval scale the scores of 3 and 6 are equivalent to the scores 23 and 26. The scores imply that one alternative scores 3 units higher than another, but whether this represents a doubling or just a tiny change cannot be determined.

Ratio

A ratio scale has a natural origin (zero value), and provides a measure of both difference and magnitude. On a ratio scale the scores of 3 and 6 would indicate a doubling of the score, whereas the score 23 and 26 would indicate a relatively small increase of 13 percent.

The scores may not necessarily be linear or even a simple increasing or decreasing function of a natural attribute, e.g., pH might be chosen as an indicator for water quality. Neither extremely low nor extremely high pH's are desirable so the score for the water quality criterion might vary with pH.

Scores obtained by directly measuring "real" attributes will generally have a ratio scale. Ordinal or interval scales are more common when scores are constructed by other means.

Since measurements such as +++, ++, + must be translated to at least an ordinal scale if they are to be used in any useful way, "qualitative" and "ordinal" are used interchangeably and "quantitative" is reserved for interval or ratio scales.

In Table 29.1, tourism and recreation has an ordinal scale, soil erosion has an interval scale, and employment and income both have ratio scales. Preservation and tourism are being regarded as qualitative and soil erosion, employment and income are seen as quantitative. This nomenclature differs slightly from standard mathematical practice, where "quantitative" is used to refer to any measurement expressed as a number and therefore includes ordinal scale. Methods based on interval scales provide a complete ordering of the alternatives, whereas methods with less vigorous data requirements can conclude that two alternatives are not comparable on the basis of available information.

The type of measurement to be used for each criterion is influenced by what makes sense in terms of the overall objectives (that is, the criteria at the top of the hierarchy), the available information and the evaluation method desired.

Before applying some evaluation methods, in particular those in which the numerical value of the score is used directly to rank alternatives, it is necessary for all criterion scores to be reduced to a comparable or standardised basis. Standardisation should not be confused with weighting. Standardisation is intended to eliminate effects. A simple example of standardisation is ensuring that dollar amounts are all expressed as actual dollars for some criteria and thousands of dollars for others. Standardisation is an issue only for evaluation methods that use the actual numerical value of a criterion to obtain a ranking of the alternatives.

Assigning Weights to the Criteria

Assigning weights to the criteria is possibly the most valuable aspect of multi-criteria analysis because it allows different views and their impact on the ranking of alternatives to be expressed explicitly. Weights represent social preferences, and therefore the question of who specifies the weights becomes important.

Weights can be assigned directly by the individual carrying out the analysis to represent hypothetical points of view, they can be based on data collected from opinion polls, focus groups or other direct forms of sampling public or expert opinion or they can be generated mathematically. Some evaluation methods require all weights to be quantitative, some use, either quantitative, or qualitative weights (ranking) and others use only qualitative weights.

It is desirable to consider sources of implicit weights when selecting and defining criteria and to reduce their effect as much as possible. Implicit weights can enter the analysis through choice of criteria. For example, selecting 4 criteria to represent environmental quality and only two criteria to represent economic growth could introduce a weighting in favour of environmental quality. The scale on which the criteria are scored can also introduce an implicit weighting.

Evaluating the Alternatives

The alternatives are evaluated by applying a mathematical procedure to the effects table and the criterion weights, to produce a ranking of alternatives. The choice of evaluation method is dictated to some extent by the different methods, nature of the effects table, and if there is no ideal evaluation method, the type of weight information.

Some methods require quantitative data. Some are designed for qualitative (ordinal) data, and some can deal with a mixture of quantitative and qualitative data. For any problem, however, there may be several possible methods and no obvious reason for choosing one method over another.

- Apply different methods. Results are similar then choice of method is not critical; and
- Apply different results. Information in the effects table is not capable of distinguishing between the alternatives in an unambiguous way.

Sensitivity Analysis

In a sensitivity analysis, various aspects of the multi-criteria problem, such as scores, weights, standardisation methods, evaluation methods, are varied systematically to determine their effect on the ranking of the alternatives. Sensitivity analysis can be a very powerful tool because it reveals the strengths and weaknesses of the multi-criteria analysis, e.g., if the ranking of alternatives is insensitive to different methods of scaling a criterion, the choice of scaling is unimportant. The scaling method influences the ranking, requiring more attention to this criterion. It is also possible to determine, for example, how much a particular weight must change before the ranking of two alternatives is reversed.

Since the objective of a multi-criteria analysis is to assist in the decision making process, presentation of the results in a form easily understood by the decision maker (or makers) is extremely important. One of the main advantages of multi-criteria analysis is its potential to simplify a mass of complex information. Multi-criteria analysis is most valuable where it is an interactive process involving the decision maker from the very beginning. Graphs are helpful in illustrating the results of sensitivity analysis.

Dealing with Uncertainty

Uncertainty arises when there are several sources, e.g., multiple scores that appear in the effects table, and one is not certain about some of these estimates or parameters. For example, the amount of soil erosion associated with a particular alternative may not be known exactly. Other sources are:

- Uncertainty in the analysis may be due to the inability of the selected criteria to adequately represent the objectives that the decision maker is trying to achieve; and
- Uncertainty surrounding the assignment of weights.

Sensitivity analysis is one way of handling uncertainty.

Multi-criteria analysis can be applied to several environmental and resource issues, but it has its own strengths and weaknesses. The strengths and weaknesses of the multi-criteria are summarised in Table 29.2.

Table 29.2: Strengths and Weaknesses of Multi-criteria Analysis

Strengths	Weaknesses
• Provides structure for decision making while still allowing flexibility;	• Does not overcome fundamental problems associated with comparing quantities that some would argue are not comparable, but does provide more flexibility than is available with, say, benefit-cost analysis;
• Particularly useful for complex problems where the amount of information exceeds the integrative capacity of the human brain;	• Variety of evaluation methods available without any clear indication is better than another;
• Follows naturally from the way people tend to approach problems with multiple objectives – A familiar analogy of the effects table is a table comparing specification for several models of motor cars;	• Since many of the methods are complex and remain a 'black box' to the decision maker they can lead to either mistrust or excessive faith in the results.
• Flexible data requirements – methods are available for qualitative data, quantitative data, or a mixture of both;	• Concentration on the definition of explicit weights can provide a false sense of objectivity about the remainder of the analysis – there are opportunities for introducing implicit weights at all stages of the analysis and these may remain undetected;
• Allows different points of view to be dealt with explicitly through the weights;	• Considerable effort is needed to obtain the information for the effects table and weights; and
• Allows information that is agreed upon by all parties to be distinguished from areas on contention (indicated by different weights)	• Methods for incorporation of uncertainty explicitly into the analysis are not yet well developed.
• Amenable to sensitivity analysis to determine how robust the final results are to changes in the underlying assumptions and methods;	•
• Does not require assignment of a monetary value to all quantities; and	•
• Can identify where additional data would be useful and where additional data would have little impact on the final decision.	•

Source: RAC (1992)

KEY REFERENCE

RAC. (1992) *Multi-Criteria Analysis as a Resource Assessment Tool*. RAC Research Paper No. 6, March 1992, Resource Assessment Commission, Canberra, Australia.

PARTICIPATORY RESEARCH METHODS AND TOOL KITS

Introduction

The past two decades have seen an increased recognition of the importance of participation by beneficiaries and a wide range of other stakeholders in decision making. This has led to the development of various participatory approaches, tools and methods. Experience has shown that participation improves the quality, effectiveness and sustainability of development actions. Various participatory techniques have been used in the planning, implementation and evaluation of projects. Thus, in this chapter the concept of participation defined, a brief description of the emerging participatory methods presented and the various tools used are outlined.

Participation and Participatory

The notion of people's participation is now widely recognised as a basic operational principle of development programs and projects. Participation has become a widely accepted strategy for planning implementation and evaluation of Research and Development (R&D) projects, yet is understood in many different ways. In the literature, a distinction is made between "participation" and "participatory". The term participatory development has sometimes been defined as involving users and communities in all stages of the development process (Narayan, 1993). On the one hand, participation has been defined by one author as "voluntary or other forms of contributions by rural people to pre-determined programs or project" (Oakley *et al*., 1991: p.8.). Activities, such as participation in a survey, serving as key informant, or participation in an experiment which is researcher managed could be described as participation. On the other hand, a participatory project has been described as one initiated and "owned" by beneficiaries (Cummings, 1995). Thus, participatory programs contribute to empowerment of the individuals and communities involved in the programme. Participation can be a product as well as a process. As a product, the act of participation is an objective in itself, and is one of the indicators of success. On the other hand, participation is viewed as a process when the act of participation is used to achieve a stated objective, such as improving a family's knowledge on child nutrition. In practice, therefore, there is little to be gained from such distinctions between participating and participatory in practical fieldwork.

The popularity of participatory approaches is based on the assumption that they eliminate the weaknesses of the traditional 'top down' approach to research and development. Participatory approaches value the input of the beneficiary and are associated with increasing the respect for an incorporation of indigenous knowledge in all aspects of a program or project. In the FSA-TDT process participation occurs during the entire project cycle namely problem identification, project design including feasibility analysis, project implementation, monitoring and evaluation, development of the final recommendation and the eventual feed back.

Many different types of farmer participation exist, and can be classified according to the degree of initiative and involvement of beneficiaries. Ashby and Sperling (1995) classify the methods of participation as follows: *functional participation* (to get something useful accomplished); *empowering participation* (to give a community a greater decision- making role) and *capacity building participation* (to enhance the skills of the community). Martin and Salman (1997) identified the following categories of participation: *contractual participation* (to provide specific services); *consultative participation* (to get information); collaborative participation (work as partners) and *collegial participation* (strengthen farmers research). A third classification (Britha, 1995) is *passive participation* (where most decisions are made by outsiders; mostly one way communication between outsiders and local people); *active participation* where there is two way communication (people get an opportunity to interact with outsiders); *participation by subscription* (where the local people are given an opportunity to subscribe to the project and in turn receive some benefits from the project) and *participation based on local request* (demand driven approach where planned activities respond to the needs expressed by local people). A similar but a simplified grouping of types of participation is provided by Dixon and Singh, 1995. Here participation is classified as *unfolded* (indigenous process initiated and controlled by local communities), *facilitated* (intervention by outside agents, to liberate and empower), *induced* (influenced by outside agents to manipulate for external purposes) and finally *co-opted* (coercion by outside agents behaviour modified by fear or propaganda). This clearly demonstrates the fact that there are no universal interpretations or models of participation applicable to all development program or projects. The degree of empowerment of farmers varies from great, in cases of 'unfolded' participation, to virtually nil in 'co-opted' participation. It is worth noting that these classifications are based on the degree of involvement of the community as well as their focus.

In development projects, the evidence to date would suggest that in broad terms people's participation develops along a continuum. It invariably begins with *passive participation* where beneficiaries basically welcome the project proposals and support them, but are generally cautious in relation to project management. This will result in *increasing involvement* where beneficiaries begin to develop more trust in the project and more contact with its activities and staff; they may also begin to take on some responsibilities. The next step is the *active participation* where beneficiaries play the role of active partners in the projects implementation and development and assume increasing responsibility. The final stage is *ownership/empowerment* where, beneficiaries are both willing and able to sustain and further develop the initiatives begun by the project.

Pros and Cons of Participation

There are arguments for and against the promotion of greater people's participation. These are summarised in Table 30.1.

Table 30.1: Advantages and Disadvantages of Participation

Advantages	Disadvantages
• Participants can improve the efficiency of activities by involving local resources and skills – can make better use of the expensive external inputs	• Costs time and money, with no guaranteed impact upon the end product.
• Can enhance the effectiveness, as the activities are more relevant to local needs.	• Process of participation are irrelevant and luxury in situation of poverty and will be hard to justify expenditure.
• Build local capacity and skills to manage and negotiate development activities	• Can be a destabilising force in that it can upset the existing socio-political relationships.
• Can enhance the project coverage as local people are able to assume some of the burden of responsibility.	• Is driven by 'ideological fervour' and less concerned with seeking to ensure direct benefits for people – promoting an ideological perspective into development.
• Can lead to better targeting via identification of key stakeholders.	• Participation can lead to shifting of the burden onto the poor.
• Can help to secure sustainability of activities as beneficiaries assume ownership.	
• Can meaningfully address gender considerations – providing opportunity to play a part in development work.	

Evolution of Participatory Approaches

The systems oriented participatory approaches to technology development and dissemination emerged as a result of the realisation that the transfer of technology (ToT) paradigm of industrial and green revolution agriculture had not worked well within the complex, diverse and risk prone agriculture, prevalent in the semi-arid, sub-humid and humid tropics. Historically, non-adoption of recommendations was attributed to farmers' ignorance, to be overcome through more and better extension, and then to farm level constraints, with the solution in easing the constraints (Chambers, 1993). The reasons for non-adoption of technologies are well documented (Byerlee and Collinson, 1980; Norman *et al*, 1994; Anandajayasekeram, 1996; Matata *et al.* 2001). However, evidence shows that farmers are far more knowledgeable and better informed than agricultural professionals used to suppose; and farming conditions are, and will remain, different from those prevailing at the research stations.

The new paradigm is based on the premises that the non-adoption of technologies is not due to ignorance of the farmers but due to deficiencies in the technology and the process that generated it, especially inadequate participation in all stages of the process by those intended to benefit. In this new paradigm farmers analyse, choose, experiment and evaluate, while outsiders convene, catalyse, advise, search, supply and provide support and consultancy.[14] The salient feature of the new approach is the reversal of

[14] For a detailed discussion of the major differences between the traditional approach and the participatory approaches to technology development and transfer see Anandajayasekeram, 1996.

learning; where researcher and extension workers are learning from farmers. The key elements of the new paradigm are to put emphasis on people rather than "things", to decentralise, empowerment of the participants, to value and work on what matters to participants (subjective perspective), and to learn from the beneficiaries rather than to teach them. Location and roles are also reversed, with farms and farmers as central instead of research stations, laboratories, and scientists. It has been argued (Chambers, 1993) that much of the earlier farming systems work could be seen as an extension of TOT, where outside professionals obtained information from farmers, analysed it and decided what would be good for the farmers, and what experiments should be designed and executed. In contrast, in the new participatory approaches analysis, choice and experimentations are conducted with and by farmers themselves, with outside professionals providing catalytic facilitating and support role. The major shifts in paradigm are summarised in Table 30.2

Table 30.2: Shift in Paradigm in TDT

ATTRIBUTES	PRIOR TO INTRODUCTION OF PARTICIPATORY APPROACHES	NOW
• Mode	• Blue print, supply push	• Process, demand driven
• Key words	• Planning, transfer, farmers	• Participation, empowerment, rural, community
• Goals	• Pre-set; closed	• Evolving; open
• Decision making	• Centralised	• Decentralised
• Methods, rules	• Standardised; Universal	• Diverse; local
• Analytical assumptions	• Reductionist	• Systems; holistic
• Interaction of professionals with people	• Instructing, motivating	• Enabling, empowering, facilitating
• Local people seen as:	• Beneficiaries, passive	• Partners, actors
• Outputs	• Uniform	• Diverse: based on capabilities
• Planning and action	• Top-down	• Bottom-up

Source: Adapted and modified from Chambers (1993) and Veenhuizen (1999)

FSA to technology development and dissemination is a category of research that features collaborative interdisciplinary work. This research approach addresses the specific needs of a particular target group of farmers and emphasises on on-farm activities and farmer participation in all stages of the process. The various stages, objectives and activities of FSA-TDD are presented in Table 30.3. In its development, farmer focus, systems perspective and technology generation have remained at the forefront while other themes have shifted in emphasis.

Rapid Rural Appraisal (RRA) emerged in the late 1970s as approaches and methods of inquiry about rural life and conditions to avoid the many defects of large questionnaire surveys. RRA is a systematic semi-structured survey by multidisciplinary teams designed to acquire quickly information on rural life (Conway *et al.* 1998). It has the flexibility to adjust to situations because it does not require a standard set of methods to be applied in each case. The methods applied vary from situation to situation and are determined by local conditions, local problems and objectives at hand (Mukherjee, 1997). RRA stressed and continue to stress cost-effective trade-offs between quantity, accuracy, relevance and timeliness of information. Methods and concerns include semi-structured interviewing and management of team interaction (Carruthers and Chambers, 1981). In the 1980s agro-eco system analysis (Conway, 1986) contributed to another powerful stream of methods including sketch mapping, transects and diagramming.

Table 30.3: Stages, Objectives and Activities of FSA

Steps/Participants	Objectives	Activities	Concern
Diagnosis Farmer Researcher Extension Staff NGOs Delivery Agents	– To identify `tentative' target groups – To describe and understand the production systems: What? How? Why?, Who? And when? – To identify the priority enterprises in the system – To identify and prioritise problems and constraints – Problem analysis to establish causal factors and possible systems interactions – To identify potential solutions to the identified problems – To gather initial reactions to the proposed solutions/technical options from the Target Group of Farmers	– To identify the `Tentative' target group based on secondary data, site visits and key informant surveys. – Collection, analysis and synthesis of available secondary information related to the target group – Generation of primary information using one or more of the available diagnosis tools.	– Appropriate methods – Focus (individual vs. group) – Farmer participation – Gender Sensitivity – Policy and institutional constraints
Planning Researcher including commodity/ disciplinary researchers, farmers appropriate extension staff, at times NGOs and policy planners	– To identify feasible solutions to identified priority problems – Plan diagnosis and experimental activities. – To formulate annual work programs giving due consideration to available resources. – Include both bio-physical and socio-economic research.	– Identify potential solutions – Screening to identify feasible solutions – Identify list of activities – Work out the details of each activity (design, treatment etc), including annual resource requirement – Develop annual work plan by matching activities with available resources	– Farmer participation – Sustainability consideration
Experimentation/ Implementation Research and extension staff, farmers, NGOs.	– To implement the experiment in the most efficient manner keeping in mind the objectives of the experiment – To complete socio-economic investigations	– Planning of Survey – Farmer selection – Site selection – Arrangement with farmers – Layout of the experiments – Treatment management – Monitoring and data collection – Informal evaluation (on-going) at the site	– Farmer participation in management – Cost effectiveness – Farmer assessment
Evaluation Depending on the nature of the experiment Researcher, Extension staff, Farmers and bio-metrician	– To assess the performance, in relation to objectives relevancy and appropriateness for the target group.	– Review and circulation of reports – Scrutiny of the data – Data analysis - Statistical - Agronomic - Economic - Farmer assessment - Environmental implications	– Farmer assessment – Wider adaptability – Sustainability considerations – Gender consideration – Socio-cultural impact – Feed back to policy makers
Re-planning Research and extension staff, NGOs	– To confirm original hypotheses regarding group, problem statement and priorities. – To adjust the treatments to reflect new information generated.	– Same as for planning	– Farmer Participation
Recommendation and Wider Dissemination Research and extension staff, NGOs.	– To test the technology across population. – Formulation of extension messages including monitoring and feed back. – Scaling up	– Demonstration – Field Days – Workshops – Training of frontline extension staff – Developing messages, pamphlets, bulletins, etc.	– Impact – Feed back – Broader participation – Scaling up

Source: Anandajayasekeram 1996

Participatory Rural Appraisal (PRA) is a continuing outgrowth from RRA. PRA is described as a "family of approaches and methods" (Chambers, 1993 & 1997) and evolved from FSR and RRA. PRA is a way of learning from, and with, community members to investigate, analyse and evaluate constraints and opportunities, and to make informed and timely decisions regarding development projects. PRA aims to fully involve farmers (both women and men) of the target group in the identification of their problems and to initiate their own solutions. PRA is not limited to agriculture or FSR alone but it is also frequently applied in general for community development projects. PRA methods reinforced some of the techniques used in RRA and added on new tools and above all emphasised broader community participation. The proponents of PRA argued that RRA is extractive with outsiders appropriating and processing the information whereas PRA is participatory with ownership and analysis done more by rural people themselves. With PRA it is less outsiders, and more local people themselves who map model, diagram, rank, score, observe, interview, analyse and plan. The key innovations of RRA are methods such as (semi structured interview, methods for team interaction, sketch mapping, decision trees and causal diagramming). The creativity in devising and using these methods was that of the outsiders. The key innovations in PRA have been behavioural. Both RRA and PRA rejected conventional professional norms and behaviour and developed and shared new methods.[15] One of the most promising developments has been visual sharing and analysis through diagrams.

In the early 1990s the frontier continued to move. There was renewed attention to questions of whose knowledge counts - that of scientists or that of farmers? Knowledge and priorities vary - both within communities; differing for individuals, groups and gender, and between rural people and outside professionals. The interaction between outsider professional and rural people has become a focus. Some of the most recent versions of participatory methods for diagnosis and community planning are 'Participatory Learning and Action' (Wetmore and Theron, 1998), and ‘Participatory Assessment and Planning’ (Farm, 1998). These are community management tools that facilitate broader stakeholder participation and community planning in an interactive way. These approaches help the community to make its own development plan based on the community needs and to prepare a program of action to translate the plan into reality. In addition to these broader approaches a large number of other participatory methods have emerged in the recent past. The list of key participatory methods that are being introduced into the Eastern and Southern African region is presented in Table 30.4. The most commonly used approaches are RRA, PRA, Participatory Learning and Action (PLA) and Participatory Assessment and Planning (PAP). The various tools used in these approaches are outlined in the next section.[16]

Table 30.4: Participatory Methods and their Focus

METHOD	FOCUS
• Rapid Rural Appraisal (RRA)	Diagnosis and Planning
• Participatory Rural Appraisal (PRA)	Diagnosis and Planning
• Participatory Rural Appraisal and Planning (PRAP)	Diagnosis and Planning
• Participatory Assessment and Planning (PAP)	Diagnosis and Planning
• Participatory Learning and Action (PLA)	Diagnosis, Planning, and Implementation
• Participatory Impact Monitoring (PIM) • Participatory Monitoring and Evaluation	Monitoring and Evaluation
• Participatory Farm Management Methods (PFM)	Planning in farm and household
• Participatory Extension Approach (PEA)	Extension
• Participatory Rural Communication Appraisal (PRCA)	Information and Communication
Rapid Appraisal of Agricultural Knowledge Systems (RAAKS)	Information and knowledge systems
• Agricultural Knowledge Information Systems (AKIS)	Information knowledge systems
• Agricultural and Rural Knowledge System (ARKIS)	Information and knowledge system (continued on next page)
• Participatory Technology Development (PTD)	Diagnosis, Planning, Implementation and Evaluation
• Participatory Livelihood Analysis	Livelihood
• Participatory Poverty Appraisal	Poverty

[15] For a detailed discussion of methods development, see Anandajayasekeram and Dixon, 1998.

[16] For a good account of comparison of the four methods reader is referred to Anandajayasekeram, P., A. Torkelsson and J. Dixon, Emerging Participatory Approaches to Technology Development and Transfer. What is new? Occasional paper, FARMESA, Harare,Zimbabwe.

Tool Kits

A large number of tools and techniques are currently being used in the various participatory approaches to research and development (R&D). A summary of tools is presented in Box 30.1

Box 30.1: Tools and Techniques used in PRA

- Review of secondary data
- Direct observation – measurement
- Semi structured interview
- Key informant interview
- Focus Groups discussions
- Ranking
  - Preference ranking
  - Pair wise ranking
  - Direct matrix ranking
  - Ranking by voting
  - Wealth ranking
- Mappings and diagrams
  - Village mapping
  - Resource mapping
  - Social mapping
  - Transect walk
  - Flow diagrams
  - Pie charts, histograms
  - Venn diagrams
  - Systems diagrams
  - Innovation tree
- Trends
  - Time trends
  - Historical profile
  - Livelihood analysis
- Gender Analysis

Semi structured interview

Semi-structured interviewing is guided interviewing where only some of the topics are predetermined and other questions are allowed to arise during the interview. The interviews appear informal, but are actually structured. Using a guide or a checklist, a multidisciplinary team poses open-ended questions and probes topics as they arise. New avenues of questioning are pursued as the interview develops. The output is usually in the form of qualitative information, but can also be quantitative form. The steps to follow in a semi-structured interview are summarised in Box 30.2.

There can be sequencing and a chain of semi-structured interviews, which can be repeated as and when required. Semi-structured interviews can be conducted with different groups in a village or community. For a detailed discussion a reader is referred to the FSA sourcebook.

Key informant survey

In key informant surveys, individuals knowledgeable about certain subjects or topics asked to supply information. They key informant survey differs from a regular survey in that the person interviewed does not answer questions about himself/herself but about the subject in which (s)/he is an expert or has a very good knowledge. A knowledgeable farmer, for example, describes the farming practices followed by the farmers in his/her area but does not describe his /her own farm. If they are carefully carried out, key informant surveys can provide a large amount of high quality, quantifiable information quickly and at low cost. Only a few individuals at any given site need to be interviewed.

Box 30.2: Semi Structured Interview – Steps to Follow

BEFORE SURVEY:

- Select the multidisciplinary survey team;
- Analyse secondary data;
- Prepare checklist for the interview (this should be a team exercise);
- Prepare the logistical side of the survey;
- Inform farmers in advance;
- Establish note taking procedure before entering the village; and
- Decide whether group discussion and/or individual in-depth interviews are more appropriate.

DURING A GROUP MEETING OR INDIVIDUAL INTERVIEW

- Be aware of the local culture and language;
- Respect farmers as equal partners;
- Do not use checklist as a questionnaire-use it as a means to stimulate discussion;
- Build questions to be asked around a list of sub-topics;
- Use guidelines for probing: who? why? What? When? Where and how?; and
- Take notes during the interview but not excessively.

AFTER THE INTERVIEW

- Finish the discussion politely;
- At the end of the day have a brain storming session, complete notes and prepare for the following day's work; and
- Establish report writing procedures as well as responsibilities among team members.

The quality of the data can be verified by interviewing two key informants about the same subject. The answers of the two informants can be compared. In most cases all the answers should be fairly close. In those cases where differences in answers occur, people can be questioned again to get the right information.

If during a key informant interview it becomes obvious that the selected person is not knowledgeable enough to answer the questions, the interview can be terminated tactfully and another more knowledgeable individual may be selected as a key informant.

Depending on the nature of the information needed, one could interview any of the following persons; experienced farmers, shopkeepers and merchants, the local extension agent, local village administrators, teacher, mid-wives, farmers who hold position of traditional leadership, input suppliers, or the leader of a farmer group or association.

Formal/verification survey

Although informal surveys can provide a lot of information in a relatively short period, there may be a further need for more specific information and quantitative data. Under these circumstances, a follow-up formal survey may be appropriate. It is important to keep in mind that this formal/verification survey is different from the traditional farm management survey. The distinguishing characteristics of a formal survey are:

- Uses standardised or structured questionnaire;
- Collects uniform set of data;
- As much as possible sample of farmers to collect information.;
- Enumerators are often used to administer the survey; and
- Problem focused verification survey.

Since the survey collect standard information from a sample of farmers, it enables the statistical analysis of the information collected.

Formal surveys are recommended in one of the following cases:

- When quantitative data are required to complete qualitative data obtained form RRAs/PRAs.

- When detailed information on individuals or households is sought rather than general information on target group.
- To compare before/after situations and the changes of farmers' conditions over time (baseline and adoption studies).
- To conduct in-depth studies of specific subjects and to test hypothesis, which have emanated from informal surveys.

See Chapter 7 for more details.

Community interview

At times, in community development oriented activities, we conduct what is known as a community interview. The objectives of this type of interviews are:

- To gather descriptive data on community and village;
- To assess community needs/problems and priorities; and
- To assess the attitude/commitment of the community with respect to planned intervention.

The advantages of community interviews are:

- It permits interaction with large group of people within a short period of time, i.e., efficient in terms of cost and time.
- In a non-threatening environment, participants tend to complement/correct/verify each others input, thus improving the quality of the information collected.

Once again, as in the case of group interview techniques, there are a number of limitations to this approach. They include:

- The local leaders and powerful community members may dominate the deliberations;
- The group may not be homogenous; and
- The facilitator should have good practical knowledge about the problem/issue to be explored.

Focus group interview/discussion

Focus group interview is another form of group interview addressing specific topic/issue confronting a group. Typically 6-8 people, who under the minimum guidance of a facilitator discuss a particular topic in detail. When the ideas and opinions of a grass root level is needed about a specific problem or intervention, then a focus group interview is the most appropriate technique to use. This type of discussions may reveal the perspective, attitude, understanding, and reactions of beneficiaries/local group.

Once again to get the maximum benefit, the group interview is cost effective, can be carried out quickly, and can obtain a wide range of information.

The Moderator of this exercise should not be biased, must possess good theoretical and practical knowledge of the problem/issue being discussed. (s)he should be fluent in the local language and should have previous experience in conducting focus group sessions.

The potential dangers are that the formal/informal leaders and influential individuals may dominate the discussions. If the issue under discussion is controversial and sensitive, then the group situation may inhibit rather than stimulate individuals' response. Focus groups are not intended to reach consensus, make decisions or agree on specific action.

Ranking

Ranking, or scoring, means placing something in order. Specific methods include:

Preference ranking, pair wise ranking, direct matrix ranking, wealth ranking

The first three methods are discussed in detail in Chapter 28 of this sourcebook. The detail of wealth ranking technique is discussed in this section.

Wealth Ranking:

Wealth ranking is a tool for identifying and ranking relative wealth status of a group of farmers. This is based on the assumptions that there are inequalities and differences in wealth in every community and these differences influence or determine people's behaviour coping strategies including adoption of technologies.

Purpose:

- It allows the team to investigate perception of wealth differences and inequalities in a community
- Discover local indicators and criteria of wealth and well-being; and
- Establish the relative position of households in a community.

Wealth ranking is based on the assumption that community members have a good sense of who among them is more or less well off. There is a need to maintain confidentiality, not to cause bad feelings within community. This is often done by using key informants. One needs a facilitator to conduct wealth ranking.

Steps:

1. Choose the community for wealth ranking;
2. Define the unit of ranking - normally household;
3. Define and understand the local concept of wealth;
4. Make a list of all households - assign numbers;
5. Identify key informants, at least 3;
6. Ask key informants to sort cards independently - using own criteria, use baskets or boxes;
7. Establish criteria used and differences between piles.;
8. Record information, establish scores for each H.H

$$Score = \frac{Household\ pile\ number}{Total\ number\ of\ piles} \times 100$$

   - All farmers in one pile will get the same number
   - Note: Rich households will have the lowest score
9. Add scores and divide by the number of Key Informants;
10. Arrange households according to wealth categories.

If informants used different number of piles, take the average. It is worth noting that this system does not work well in heavily populated areas and scores between villagers cannot be compared.

Diagrams

A diagram is any simple schematic device which presents information in a condensed and readily understandable form. It is a simplified model of reality.

Value/usefulness

- They greatly simplify complex information;
- The act of constructing a diagram is an analytical procedure; and
- Excellent way of involving community members

The possible diagrams are summarised in Box 30.3.

Box 30.3: Possible Diagrams Include

Concept	Diagram
Space	Maps, transacts
Time	Seasonal calendar, daily routine chart, daily activity calendar, time trends, historical profiles
Relation	Flow diagram, livelihoods analysis
Decision	Decision tree, Venn diagram, Innovation tree
Constraints	Problem Tree

Venn Diagram 'chapati' diagram

Venn diagrams are drawn to help understand the current formal and informal institutions in the area under study and the extent or overlap of decision-making and co-operation. They highlight gaps between institutions, opportunities for better communication and co-operation, conflicts, and sometimes the need for a new institution. In particular, they identify the locally perceived role outside agencies play in the village or catchment. The Venn Diagrams are very useful in identifying collaborative partners in a rural setting.

A Venn diagram shows the key institutions and individuals in a community and their relationships and importance in decision making. They identify locally perceived role that the outside agencies play in the village or in the community. Stakeholder analysis uses this technique. Source of information is from community. Key for the Venn diagram:

- Separate circle means no contact;
- Touching circle means Information passes between institutions;
- Small overlap means some co-operation in decision making; and
- Large overlap means considerable co-operation in decision making

Size of the circle indicates importance or scope and the distance from the centre indicates the relative importance of the agency/institution to the subject under investigation.

Flow Diagrams

A flow diagram shows causes, effects, and relationships between key variables. It is

very useful in problem analysis.

Steps:

1. Identify the problems to be analysed;
2. Consider one problem at a time;
3. Put the problem at the centre and circle it;
4. Ask about the causes of this problem;
5. Each cause is written on a separate card;
6. Discuss and probe until no more causes identified;
7. Place causes cards in correct relationship to the problem; and
8. Draw arrows.

Samples of flow diagrams are shown in Chapter 7 of this sourcebook.

Maps

Maps are diagrams showing the geographical arrangement of key features of an area of land.

- Individual fields;
- Farms - Resource flow maps/Resource allocation maps; and
- Villages/communities/districts.

The different types of maps drawn include village map, village social map, village resource map, mobility maps and transect map

Procedure for Participatory Mapping

1. Decide on what sort of map to be drawn;
2. Find people who know the area;
    - Topic of the mapping exercise
    - Who are willing to share their knowledge
3. Choose a suitable place (ground, floor, paper):
   Medium (stick, stones, pins, pencils) for the map
4. Purpose of the map should be carefully explained;
5. Help people to get started but let them draw the map by themselves - be patient, do not interrupt; and
6. Keep permanent record including mapper's names, give them credit.
   Common features of a map are:
    - Physical infrastructure;
    - Social infrastructure;
    - Cropping system;
    - Water sources;
    - Woodlands;
    - Major physical features;
    - Land tenure system; and

- Grazing areas

Things to keep in mind:

- Participants - different groups - in order to obtain unbiased view of the subject. group should not exceed fifteen members
- Location: takes time, comfortable location reasonably peaceful, free from distraction
- Equipment
  Sticks, stones, learn on cleared smooth areas of ground
  Coloured chalk on cement floor
  Coloured pens on paper

Mobility Maps:

Mobility maps provide an indication of contacts with the outside world. Contacts and decision making power in a community are assumed to be closely linked. Spatial mobility can be used as a person's contact with, and knowledge of, the outside world and his/her authority in the community. Mobility map is both a data collection and an analytical tool.

Steps:

1. Introduce the definition and purpose of mobility map;
2. Organise different groups (Gender, marital status, job);
3. Every participant completes a mobility map individually for a certain period (week, month, year);
4. Results are compared and a 'representative' mobility maps are drawn for each sub groups;
5. One person from each sub group presents the mobility map to the larger group; and
6. All participants discuss the results of the mapping exercise.
   - When using flip charts and markers use different colours for different activities, work, health, visiting, shopping, education.
   - Show differences in the frequency of mobility by making the lines thicker and thinner.

Transect:

A transect walk is a simple technique used to ensure that the team explores the spatial differences fully in the area under study. This might be a region, catchment, village, or field. The team walks to the periphery, observing trees, livestock, water availability and so on. The transect diagram produced is a stylised representation of a single or several walks by the team. The importance of a transect lies not only in knowing the agro-ecological zones in rural areas, but also in getting an in-depth account from the participating villages of such zones in the village, their uses, problems and opportunities. One transect walk can be supplemented by other walks so as to enable the outsiders to learn more about any village and clarify doubts. A transact is a diagram of main land use zones in a community or a village. It compares the main features, resources, uses and problems of different zones. Transact maps are particularly useful when there is a range of land use systems in one community

Steps:

1. Find community members who are knowledgeable and willing to participate in a walk through their village and surrounding areas;
2. Discuss the different aspects to be indicated in a transact map (crops, land use, trees, soils) and which route to take;
3. Walk the transect;
4. Observe, ask questions and listen;
5. Discuss problems and opportunities;
6. Identify the main natural and agricultural zones and sketch distinguishing features
   - Soils
   - Crops
   - Livestock
   - Problems/solutions/opportunities
7. Draw the transect;
8. Cross-check the Transect with key informants

Note: Route must be planned with the villagers

- Should pass through the main land use system

- Stop when interesting issues arise is important
- Divide responsibilities among team members' crops, land tenure, soil types etc.
- Diagram should be prepared as soon as the walk is completed
- Probe on the farming system, severity of the constraints and degree of consensus amongst villagers.

THE INNOVATION TREE

A new PRA tool, the Innovation Tree has been developed to help people to visualize and analyse the way in which innovation is spread over time between community members. It has been claimed that the tool is not only useful to distinguish between innovators, early and late adopters, but also to help both outsiders and the community to understand some for the social and psychological dimensions that influence the adoption of innovation within that community.

Why analyse innovation adoption process.

Mele and Zakaria (2003) argue that visualizing the innovation adoption process could help in:

- Provoking community reflection and raising awareness about the dynamics of the process
- Providing insights in the social and psychological dimensions underlying the innovation adoption process
- Probing which people, or more specifically personalities, to engage in a particular farmer-to-farmer extension activity.

How to develop an Innovation Tree

In order to develop an innovation tree, we need facilitator(s) and participating farmers involved in the technology development and dissemination process. Material requirement includes A4-size cards and crayons.

Steps in the process:

1. Invite households who have adopted or adapted a technology, explain objectives of the exercise and provide cards and marker.
2. Ask the individual farmers to write their name on the card along with the date on which they adopted the technology. If the farmers are illiterate, the facilitator can assist. (Picture of the participating household may also be useful).
3. Draw a line and re-arrange cards according to the date at which they have adopted the innovation.

Innovators Late Adopters

When this exercise is completed then the innovators should be at one end, while late adopters at the other. One could use the floor for this purpose.

4. The person or household who first made the innovation is asked to take the floor and explain who or what inspired to do this. One facilitator can guide the process, while another records all the comments.

5. In a chronological order all the others were asked to indicate who inspired them to adopt the idea of innovation. Lines can be drawn between farmers. The facilitator tries to find out what exactly convinced them to do it, and what other than personal factors were involved in the decision making process. An example of an Innovation Tree transferred to paper is presented in Figure 30.1

6. Facilitate group discussion and stimulate reflections to identify the technical, economic, social and psychological dimensions contributed to the adoption of the technology. During the process the facilitator should try to draw on the insights gained from the exercise and explore who could contribute in which way to scaling-up the innovation adoption process i.e. farmer-to-farmer extension. In selecting extension workers not only the technical but also the facilitation skills are important criteria.

Note that farmer decision-making in adopting a technology is influenced by institutional, economic, cultural, social and psychological characteristics. The social and psychological factors enhancing or inhibiting the actual adoption can be analysed directly with community through the innovation tree. Mele and Zakaria (2003) identified a list of social and psychological factors that could influence the adoption (both positively and negatively) process (see table 30.5)

Figure 30.1: Example of an Innovation Tree

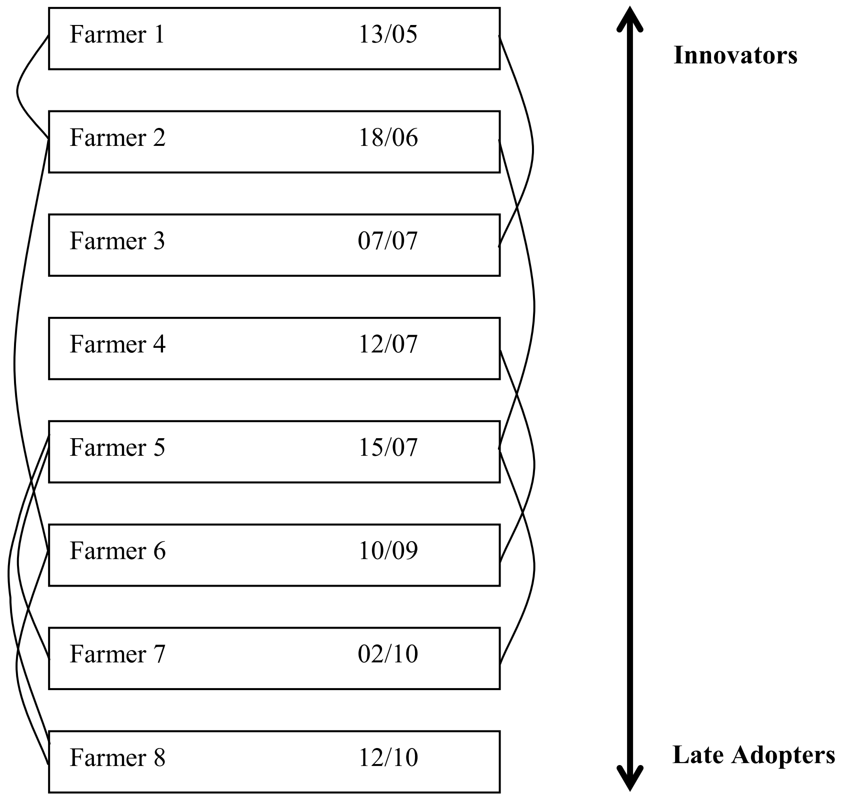

Table 30.5: Some Social and Psychological characteristics influencing adoption

Social factors		Psychological factors	
Stimulating adoption	**Inhibiting adoption**	**Stimulating adoption**	**Inhibiting adoption**
• Personal communication network	• Opposition in the farming community	• Innovation proneness	• Complexity of technology
• Social participation	• Social isolation	• Risk taking ability	• Risk avoidance
• External pressure	• Poverty	• Extravert	• High level of stress
• Common need for solving a problem		• Overall knowledge	• Lack of knowledge on the technology
		• Self fulfillment	• Lack of motivation
		• Pride of ownership	• Mistrust of project staff
		• Level of aspiration	

Source: Mele and Zakaria

It is worth nothing that this is an emerging tool and is useful to distinguish between different types of innovators, and if properly executed will enable us to understand the psychological and social dimensions underpinning the decision making process; which would be difficult to disclose in other ways. This may also yield valuable information about which people or more broadly personalities (and even institutions) to engage in a particular scaling-up activity i.e. farmer-to-farmer extension. However, in order to gain a better understanding of the adoption process, this tool need to be complemented with other tools such as semi-structured interview, personal observation, adoption survey etc.

Calendars

Calendars are diagrams showing the timing and/or importance of events over a period of time, year, production season, day.

- Seasonal calendar - main activities during seasons and off-season;
- Rainfall patterns – annual rainfall distribution;

- Crops/livestock, different practices – enterprise calendar;
- Labour calendar;
- Water sources for livestock;
- Labour migration;
- Prices of products – seasonal and trend;
- Daily activity clock
  - Men - Women
  - Winter - Summer
  - Cropping season - Off-season
  - Short season - Long season

Seasonal calendars are drawn to foster understanding of the local livelihood system. They show the patterns month by month of rainfall, crop sequences, water use, livestock fodder, income, debt, migration, wild harvest, labour demand, labour availability, health, diseases, soil and water conservation activities, pest and diseases, prices and so on.

Time Trends

Shows quantitative changes over time of the same variable. It can be used for many variables.

- Yields
- Area under cultivation
- Livestock population
- Prices
- Migration
- Population size and number of HH
- Birth and death rates
- Malnutrition rates

A time trend shows quantitative changes over time in different aspects of village life such as yields, human population, livestock population, area under cultivation prices, etc. With the help of a time trend, one can directly or indirectly see the increase or decrease of hardship in the lives of villagers.

A time trend is different from a historical transect or a time line in that a time trend is more precise in giving indication of change (increase or decrease) about a particular item whereas historical transect or time line show broad movements of different aspects of village life rather than their precise shifts.

Historical Profile

A historical profile can be done with a group of elderly villagers who have knowledge of their village to provide a historical account of the village conditions or with different tribal cultural economic groups. It can be done separately with males and females to bring out the difference in perspectives. It helps in knowing the major events and changes in conditions which have taken place in the past e.g. changes in cropping patterns, changes in vegetation, traces of environmental degradation, infrastructural changes, etc.

Historical profile reveals important information for understanding the current situation in the community. It provides a summary of key historical events in a community and their importance for the present situation such as:

Outbreak of epidemics
Drought and famine
Changes in land tenure

Livelihood Analysis

Livelihood Analysis diagrams are used to help interpret the behaviours, decisions, coping strategies of households with different socio-economic characteristics.

Variables include:

- Household size and composition;
- Livestock and ownership;
- Number of labour migrants in the H-H;
- Proportion of income by source;
- Crops

- Livestock
- Trade and Craft
- Remittance
- Expenditure by item;
- Seasonality of income generation potential;
- Relative income; and
- Credit and debt

Steps Involved

1. Clarify local definition of household.;
2. Choose variables to be recorded;
3. Choose basic socio-economic stratification such as size of the household amount of land owned, main source of income, etc.
4. Devise data collection table;
5. Obtain data;
6. Interview several community members;
7. Cross check information; and
8. Prepare livelihood analysis diagrams

Gender Analysis

Early work on participatory methods revealed that women's views and activities are as important as men's and as relevant to the design and implementation of improved technologies.

Gender consideration for technology development and transfer centre on such issues as the difference in socio-economic perceptions and expectations on the status, roles and achievements of men and women as well as the differential impact of development and change on men and women. Gender analysis focuses on four sets of questions.

- Who does what, when and where?
- Who makes what types of decisions?
- Who has access to or control over resources for production?
- Who benefits from each enterprise? What are the incentives and disincentives for production? For making changes?

The question of who benefits is closely related to roles and responsibilities as well as control of resources.

Objectives of gender analysis

- To identify major gender differentials of target group
- To identify gender specific problems, constraints and opportunities
- To develop strategies, which will enhance women's and men's participation in activities and sharing of benefits.
- To foresee effects of interventions on women and men of the target group.

Tools of gender analysis

Learning about gender requires special research methods or approaches as well research and extension staff of both genders.

Activity Profile

This profile could either be general (listing of general activities according to gender) or specific, i.e., related to livestock or crops. The profiles assist in identifying activities carried out by women, men, boys and girls; location and time spent in carrying out the activities; ascertaining that research and extension objectives are within the needs and roles of women and men in the target area, and that planning within the target group based on their calendar. The first question to be addressed is Who does what?

Procedure:

- Divide the group by gender – possible by age group;
- Explain the purpose;
- Identify various farming activities according to enterprises and other community related activities;
- Ask who is involved in these activities;

- Group according to women, men, both, youth etc.; and
- Present results in a plenary session to get community consensus

Key questions are:

- Who does what?
- How much time is spent on specific activities by women, men, boys and girls?
- What is the total workload per gender?

The second issue to be addressed is who makes what decisions. As the household level varies decisions are made with respect on-farm activities, off farm activities, allocation of household resources, use of income, etc. It is important to gain an understanding of this process.

Access and control profile

The access and control profile, like the activity profiles could be general or sectorial. This tool is used to specify access to and control over the resources and benefits by gender. The objective is to identify resources women and men require for their work and benefits they gain; identify who has access to or control over these resources and benefits; analyse the implication in women's and men's participation in the interventions; find solutions to address barriers related to access and control over resources and benefits. Access and control profile is related to asset control and realisation of benefits.

Procedure:

1. Group farmers – (Males and females);
2. Explain the purpose;
3. Prepare a sheet for recording information;
4. Ask participants to identify the major types of resources and assets;
5. Ask who has access and who controls the resources and assets; and
6. Ask what are the sources of benefits, who receives it and uses it – if possible establish purpose.

Key questions on resources

- What resources do men and women require for their work?
- Who has access and control over these resources?
- How will access to and control over the resources affect men's and women's participation in interventions?

Key questions on benefits

- What benefits do women and men obtain from their work?
- Are the benefits commensurate with their work?
- Who controls these benefits?
- How will access and control of benefits affect men's and women's participation in interventions?

At the end of this exercise, the group should be able to complete the table given below:

Resource/Assets	Who has access	Who controls	Benefits		
			Source of benefit	Who receives	How used by whom?
Land Livestock					

Influencing factors profile

This tool is used to identify the factors affecting the existing gender situation; these factors could be legal, economic, cultural or environmental. The aim of using this tool is to identify various determinants on division of labour, access and control of resources and benefits; identify constraints or opportunities that may impact women's and men's equal participation and the sharing of benefits; develop strategies to address factors which may constrain achieving of intervention objectives.

- **Procedure**

Following either the activity profile or the access and control profile discuss with farmers the influencing factors of the situation activity profile.

These tools can be used at different stages of the farming systems approach (cycle).

The tools discussed in this section are not totally exhaustive; only the most commonly used tools and techniques are outlined in this chapter.

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EXPERIMENTAL EVALUATION

Introduction

In an evaluation the impact of the technology/intervention on the individual farms/systems is assessed. Depending on when during the research cycle evaluation is performed, it can be ex-ante, on-going, or ex-post. Traditionally, experimental results are assessed using statistical techniques. Over the years, it has been demonstrated, however, that the criteria used by farmers to evaluate and adopt technologies may be totally different to that of researchers. Very often socio- economic considerations play a major role in accepting or rejecting a technology. In this Chapter, various criteria and simple techniques used to assess the performance of a technology are discussed.

Need for Broader Evaluation

Traditionally, biological scientists, using statistical techniques have evaluated agronomic trials. The dominant evaluation criterion used has been yield per unit area. The primary objective in this type of evaluation is the maximum exploitation of the biological potential and the test used is statistical significance. Normally the experimental treatments are tested at 0.01, 0.05, and 0.10 percent level. If they do not pass this statistical test, they are not considered any further. In a systems context, this approach has many limitations in deriving recommendations:

- The evaluation criteria that a farmer may use are varied, location specific and depend greatly on the degree of market orientation. The appropriateness of any technology should always be evaluated in relation to the farmer's priority objectives and resource use pattern. The relevant criteria for the target group must be identified and used in the design and interpretation of the experiment. A number of physical, biological and socio-economic variables influence the farmers' choice of technology. Very often the socio-economic factors, such as lack of marketing, shortage of labour, clash with food priority, etc., determine these choices.

- Agronomic data only establish establishes the technical relationships, which can be used to determine the technical optimum. It should be complemented with market information in order to establish the economic optimum. The 'economic optimum' for any input is always lower than the `technical optimum' (as long as that input has a positive cost).

  If the treatment yield means are not significantly different, but an economic analysis shows that one treatment is a better recommendation than the others, then we need to have a more careful analysis – a so called minimum cost analysis. Consider all treatments in the experiment or trial and choose time treatment with the lowest cost. Examples of situations where farmers choose technologies even without significant differences in yield may be:

  - Varietal yield means may not be different, but one can observe differences in palatability (preference), prices, storability, early maturing, etc.;
  - Yields may be the same but costs may be very different;
  - A new technology may not increase the yield /profit, but may reduce the labour requirement at the critical period;
  - A new technology may provide possibility of introducing a second crop, i.e., increasing the total production of the system; and
  - The intervention may reduce malnutrition in the target group.

  It should be remembered that these variable attributes are also valid in a situation where there is significant difference in yield between treatments.

  It is important to remember that a farmer is managing a system and s/he is interested in improving the total production of the system without creating serious contradictions to her/his priority objectives and resource use patterns.

- Farm level decisions are made and actions are taken in an attempt to reach goals in a world of uncertainty and scarcity of resources. These two elements are therefore crucial in assessing the impact of any technology.

Thus it is necessary for the biological scientist to conduct economic analysis in a similar manner, as s/he is responsible for the statistical analysis of the trials. The usefulness of the result of many bio-physical research experiments can be greatly enhanced if relevant economic analyses are applied to the results. Therefore it makes sense for biological scientists and agricultural economists to jointly evaluate experiments to establish both biological and economic viability. The importance of linking statistical and economic analyses is highlighted in Box 31.1.

Box 31.1: Statistical and Economic Assessment

Performing an economic analysis does not underestimate the importance of the statistical analysis. It is important to keep in mind the following facts in relation to statistical analysis:

1. The greatest value of the statistical analysis is not in deriving recommendations but in determining what is happening biologically in the experiment.
2. The rigor with which the statistical tests are applied declines as we move towards the verification trial.
3. The results of the statistical analysis will determine the coefficients to be used in the economic analysis (e.g., partial budget) as well as the technique to be used. For example if one is testing two (2) varieties and the varietal yield differences are not significant, then in economic analysis one should use the same yield figures for both varieties. In this case the appropriate technique is minimum cost analysis. On the other hand if the varietal means are significantly different then a budget could be developed to compute the rate of return.

Statistical and economic analyses are one step in selecting a new technology. In conducting economic evaluation, a research team assumes that it is familiar with the important costs and returns associated with the new technology and the decision criteria that they use are similar to those used by the farmers. There may be instances where a technology may be economical in terms of costs and benefits but may have an adverse social effect, or may not be compatible with the cultural norms of the target group. Despite its economic superiority the target group of farmers under these circumstances may not accept the technology. It is at this point that there is a need to assess the socio-cultural effect of the technology.

The socio-cultural effects can be of various forms. Some of these are given in Box 31.2. It may not be possible to quantify all the effects but a qualitative assessment that spells out that there are no significant negative socio-cultural effects associated with the technology will be adequate. Comparison or a survey (in formal farmer evaluations) could be useful approaches to assess the socio-cultural effect of any technology.

Box 31.2: Some Example of Socio-Cultural Effects of a Technology

- Poverty reduction;
- Improvement of status of women;
- Employment creation/reduction in labour requirements;
- Distribution of benefits;
  - across tender
  - across wealth groups
  - across locations
- Effect on food security;
- Nutritional effects; and
- Contradict the norms, beliefs and attitude of the target group.

The socio-cultural analysis is based on the farmers' perceptions

Economic Evaluation

Economic evaluation of any technology can be assessed at two levels. At the micro-level, it looks at the effect of the technology on the individual farmer (private effect). The effect of the same technology can also be assessed at the aggregate level-macro level- to look at the effects on the society and other sectors of the economy. At the macro level (National, Provincial, Regional) the Government administrators and policy makers may evaluate tire effect of a technology in many different ways such as:

- Cost to the government,
- Welfare gain to society;

- Implications for the market and industry;
- Implications for input supply, employment, etc.;
- Implication for balance of payment and trade;
- Implication for income distribution;
- Distribution for benefits between producers and consumers;
- Implication for food security; and
- Implication for nutritional status, etc.

Though these macro aspects are very important in assessing the effects of technology, it is beyond the scope of this Training Manual to discuss them.

This training manual deals with the micro-level economic analysis of agronomic results of the trial program. At the micro level we are interested in looking at the costs and benefits that accrue only to farmers who adopt the new technology. Economic evaluation looks at the following aspects simultaneously:

- Profit;
- Risk; and
- Systems compatibility;
  - Objectives and preferences;
  - Resource availability and use pattern; and
  - Other factors that need to be considered include institutions and infrastructure; and social and cultural acceptability as discussed in the previous section.

Having established the need for performing economic analysis on the trial data it is important to choose the appropriate technique to accomplish this task. The technique should permit us to achieve our goals and at the same time should be simple enough to be followed by both biological and social scientists. Although there are sophisticated techniques available for this purpose, a simple tool such as *partial budget* is adequate as we very often deal with a few important factors and leave all other variables at the farmer level or set at a *fixed* level. Even in on-station trials, only the treatment factor is varied while leaving other variables set at fixed levels. We often compare alternative technologies, or technological components, only. Therefore the partial budget technique is sufficient to perform many simple economic analyses and benefits of a treatment or production process. We are interested in the costs that vary across treatment and we need to have the additional costs and benefits only to make meaningful conclusions. In addition:

- A partial budget involves simple calculations and employs only a few concepts and principles of economic theory. It can therefore easily be used by biological scientists.
- One could use the partial budget to compute the rate of return on limiting resources.
- Although the tool is simple it can handle response analysis effectively.
- One can use partial budget and still handle the risks associated with technologies.
- Partial budgets can also be used to evaluate factorial and inter-cropping trials.

However it is important to remember that a partial budget will not give the net effect of a technology or production process. It only gives us the change in net benefits. Thus when using partial budgets we are not able to estimate the profitability of the enterprise or the farm. In order to estimate the economic profitability one has to construct an enterprise budget or a whole farm budget.

In economic analysis we use a partial budget to estimate the economic rate of returns. The estimated economic rate of return is used for decision making. The maximum economic limit on input use, where the Marginal Value Product (MVP) of the factor is equal to the factor price (see Box 31.3), is more meaningful to a farmer with abundant capital or credit than to a resource poor farmer. At this level the farmer makes more net income even though the efficiency with which s/he is using her/his capital and inputs is sub-optimal. In situations where farmers are facing scarcity of resources, we always try to maximise the returns per unit of the scarce factor at which point the Marginal Value Product (MVP) is greater than the factor price. Therefore the actual recommendation made is ideally dictated by the resource base of the `target group' and/ or individual farmer. The computation of Marginal Rate of Return (MRR) for the limiting factor will be discussed later. The estimated MRR will be used to make decisions.

Box 31.3: Decision Criteria in Economic Assessment

Economic Theory Suggests (in a single factor case):

i) When there is no resource constraint, the economic optimum is when

$$MVP_X = P_X \text{ or } \frac{MVP_X}{P_X} = 1$$

where: MVP_x = Is the Marginal Value Product of the factor X and P_x is the Price of the factor X.

MVP is the product of the Marginal Physical Product (MPP) of the factor and the price of the product/ output.

ii) When resources are limited, the economic optimum is when:

$$\frac{MVP_X}{P_X} > 1$$

iii) Thus, the General Rule is:

$$\frac{MVP_X}{P_X} \geq 1$$

Estimation of Cost and Benefit Coefficients in Constructing Partial Budgets

Although the construction of the partial budget is simple, it is often very difficult to construct a good budget. There are several reasons for this:

1. Incorrect prices of inputs and outputs are used;
2. Not all, or the wrong levels of inputs or outputs are included in the analysis; and
3. The critical limiting resources on the production process are not correctly identified.

In such circumstances it is important to keep in mind that:

- All sources of benefit and costs to farmers should be included in the analysis; and
- The realism of the costs and yield assumptions is important.

In the following section we look at some of these aspects in detail.

Estimating Benefits

The first step in estimating the economic benefit is the calculation of *Gross Field Benefit* (GFB). The GFB is the product of output by the field price of the product/output.

GFB = Adjusted yield x *Field price of the product.*

Possible errors in estimating Gross Field Benefits are:

1. Not all products of value are included in the analysis;
2. The wrong yield figures are used; and
3. The wrong prices are used.

In estimating gross field benefit it is important therefore to identify all sources of benefits, both direct and indirect. The major problem is to decide what yields and prices to be used in the analysis.

Yield Estimation and Need for Yield Adjustment

Farmers often do not obtain the same yield as researchers even when they apply the same treatment. At limes the researchers have a tendency to overestimate the yield which will benefit the farmers because the possibility of yield losses is not taken into account. The yield obtained by researchers in an on-station experiment or on researcher managed on-farm trials are generally higher than those obtained by farmers due to a variety of reasons. These are:

Management standard of the experimentation is very high:

- Small Plots: easier to manage and the quality of work is good;
- *Ad-lib* resource input: often researchers have less resource restriction than the farmers;
- Timely operation: time of planting, plant spacing, fertiliser application, weed control, pest and disease control, harvest date, etc. are done on time;
- High level of non-experimental variables. These are strictly controlled in most researcher-managed trials;
- Control. of experimental errors, and
- Use of different techniques: researcher often uses different harvesting and drying techniques, which minimise the field losses. This may not be the case at farm level.

On a management scale the researchers are likely to be at the top end but in a fanning population both yield and management levels are more likely to be normally distributed. For technology to be widely applicable, the recommendation generated should address the major proportion of the farmers and not only the good managers. Depending on the location and management of trials one can observe three major differences:

- Differences in natural factors - soil fertility, pest and disease occurrence, etc.
- Differences in management factors - this in fact is a random variable in a farm level situation.
- Differences in resource base - smallholder farmers have much fewer resources than the researchers.

There is therefore a need to adjust the yields obtained by the researchers at experimental stations to accommodate these differences.

Storage Losses:

Some of the local varieties store better than the improved varieties. If farmers store improved varieties for late sale or household consumption then they incur heavy storage losses. From this it is evident that an effective yield for the farmer is less than the actual harvest.

Abandoning of Treatments:

Very often researchers abandon some sites or some treatments due to drought, floods, insect attack, etc. This may inflate the average yield of the experiment, but the farmers cannot avoid these situations. Thus in analysing on-farm trials it is important to include these. Therefore there is a need for downward adjustment of the yield obtained by the researchers. This yield adjustment depends on many factors, some of these being:

- Location of experiments;
- Nature and complexity of the trial;
- Who managed the experiment;
- Level of the non-experimental variables; and
- Risks associated with the technology/ treatment.

Estimating Prices

The second component in the Gross Field Benefit calculation is the estimation of prices. The calculation of prices depends on whether the products are traded or not.

Traded output

Very often in analyses, the apparent market prices are used estimating benefits. The market price ignores the cost of marketing. In actual fact the price received by the farmers is less than the actual market price used. The price received by the farmer is influenced by many factors, among which the following may be important:

- Quality - farmers do get a discount or a premium depending on the quality;
- Variety - some varieties fetch a higher market price than others;
- Quantity sold - large volumes may have some price discount;
- Location of the sales - Local market vs. urban centre;
- Market in which the product is sold - Formal vs. Informal markets; and
- Time of the sale - seasonal variation in prices.

For the formal market, one could use the price at harvest adjusted to account for the marketing costs to be on the safe side. To avoid variations one could use the field price in estimating benefits. See Box 31.4 for a definition of the field price.

Non Traded Portions/Outputs

For commodities/by-products that is not readily marketed, one has to estimate an opportunity price. The opportunity price is approximately what it would cost a farmer to buy the product if s/he had to buy it at the market.

Note: The effective value of the product to the farmer is always less than the market price.

Box 31.4: Field Price

Field price (output) is the value to the farmer of an additional unit of production in the field prior to harvest. Depending on the end. use of the product one could use either the monetary field price or the opportunity field price.

Monetary field price: the market price of the product minus harvest, shelling and marketing cost. Opportunity field price: Opportunity Field Price of any enterprise is the price that the farmer has to. pay in order to acquire an additional unit of the product for consumption. For subsistence farmers, opportunity field price is the appropriate price to use.

If the product is sold later in the season then:

Monetary Field Price (FP) = *Price received by the farmer-(cost of harvesting and shelling + storage cost + marketing cost)*

If sold immediately then:

Monetary Field Price = *Price received by the farmer at the point of sale - (cost of harvesting and shelling + marketing cost)*

or, if:

Field Price = *Price received by the farmer at the point of sale minus the marketing costs*

Then:

Harvesting and shelling costs must be included under variable costs.

Estimating Variable Costs

Once again in many budget analyses there is a general tendency to underestimate the cost that vary across treatments due to:

- Failure to include all items which have an economic cost from the farmer's point of view; and
- A tendency to underestimate the per unit cost of inputs to the farmer.

Below we discuss certain things to be kept in mind when we try to estimate prices.

Purchased material input

The effective cost of an input for the farmer is higher than the purchased price of input in the market. This is due to several factors.

i. Credit and interest charge;

ii. Transaction costs involved in buying the input; and

iii. Cost of transportation from purchase point to the field.

Therefore the real cost of purchased input is always greater than the market price. In estimating input costs, begin with the local market price and adjust this price for other costs involved in order to estimate the real cost of inputs to the farmers.

Non-purchased material inputs (seed, manure, fodder, etc.)

Here use the value of input in alternative use or adjusted market price. For inputs with no well defined market prices use opportunity cost.

Box 31.5: Estimating Field Prices

From a fertiliser experiment on maize the following economic data were given (in Zimbabwe $):

Selling price of maize (at GMB)	=	$16.38 per 91 kg bag
Transport cost of maize (to GMB)	=	$1.30 per 91 kg bag
Harvesting and shelling cost estimate	=	$1.00 per 91 kg bag
Cost of bag	=	$1 00 each
Cost of compound Z fertiliser	=	$18.56 per 50 kg bag
Cost of ammonium nitrate	=	$20.30 per 50 kg bag
Transport cost of fertiliser	=	$1.00 per 50 kg bag
Transaction cost of purchasing fertiliser	=	$1.50 per 50 kg bag

Calculate the field prices for maize and fertiliser respectively:

A) *Field price of maize*

By definition Field Price of Maize	=	market price - [cost of harvesting, shelling and marketing cost]
Selling price at GMB	=	$16.38
Harvest & Shelling Cost	=	$ 1.00
Transport cost	=	$ 1.30
Bagging cost	=	$ 1.00
Field price	=	$13.08 per 91 kg bag
Or		$ 0.14 per kg

B) Field price of fertiliser FP	=	Market Price + Marketing (i.e., acquisition) cost
i) Price per 50kg:		
Compound Z	=	$18.56
Transport cost to Farm	=	$ 1.00
Transaction cost	=	$ 1.50
Field price of 50kg Comp. Z	=	($18.56 + $1,00 + 1.50) = $21.06
ii) Price of 50 kg AN	=	$20.30
Transaction cost	=	$ 1.50
Transport cost to farm	=	$ 1.00
Field price of 50kg AN	=	$22.80

Equipment use (derived field price)

If services are traded use market price, i.e., rental price (be aware of seasonal price changes). For own equipment (e.g., sprayer, ploughs, etc.) estimate the cost per hectare for use of the equipment:

$$Annual\ cost\ of\ a\ sprayer = \frac{(Purchase\ price - Salvage\ value)}{(Life\ of\ the\ equipment)} + annual\ repair\ and\ maintenance$$

$$Cost\ per\ hectare = \frac{Annual\ cost}{No.\ of\ ha\ over\ which\ the\ equipment\ is\ used}$$

Error! Bookmark not defined. For example, the purchased price of a plough was estimated at South-African Rand at R6 420. The salvage value of the plough was R1 209.

The useful life of the plough was estimated at 5 years. The annual repairs and maintenance cost was R50.00. The average number of hectares ploughed per year was 150. Estimate the ploughing cost per ha.

$$Annual\ depreciation\ cost = \frac{(Purchase\ price - Salvage\ value)}{Useful\ life\ of\ the\ plough}$$

$$Annual\ depreciation\ cost = \frac{6{,}420.00 - 1{,}209.00}{5}$$

$$= \frac{5{,}211}{5}$$

$$= R1042.2$$

Error! Bookmark not

$$Total\ annual\ cost = annual\ depreciation + annual\ repairs\ and\ maintenance\ cost$$

defined. $Total\ annual\ cost = R1{,}042.2 + 50.00$

$$= R1{,}092.20$$

$$Ploughing\ cost\ per\ ha = \frac{(Total\ AnnualCost)}{Number\ of\ ha\ ploughed\ per\ year}$$

$$Ploughing\ cost\ per\ ha = \frac{R1{,}092.20}{150} = R7.28\ per\ ha$$

Labour

Most farmers use family labour: In a partial budget one has to use the opportunity cost of labour, i.e., the value of labour in the next best alternative use.

Issues in estimating opportunity cost of labour:

i. The real cost of labour frequently varies over the year with labour becoming more expensive during peak demand periods. This seasonality in labour price may become quite important when evaluating a technology that places extra demand on labour during periods when the price of labour is already very high.

ii. The productivity, and therefore opportunity cost of labour may vary depending on who provides the labour (e.g., male, female, children) and for what activity (e.g., land preparation, weeding, etc.).

Note: The derivation of good estimates of opportunity cost requires familiarity with the local conditions.

Box 31.6: Points to Remember in Estimating Gross Field Benefit

1. The real cost of inputs and outputs to a farmer will usually differ from the market price.
2. The yield, which benefits the farmer; Is frequently less than the harvested yield as recorded in research trials.
3. Using experimental yield and market prices in the analysis will result in:
   - Overestimated gross benefit; or
   - Underestimated cost (this may often lead to inappropriate recommendations)

Some Hints in Preparing a Partial Budget

1. Be systematic;
2. Start with easiest/most important parameters;
3. Document all assumptions carefully; and
4. Decide on the analysis and collect relevant data during informal survey; and field visits to monitor on-farm trials.

In estimating the economic benefit, rates of returns (ROR) should be calculated for the most limiting resource in the system. This can be land, labour, cash or even water. Farmers can usually identify the most limiting resources. The steps involved in calculating ROR are:

1. Prepare the partial budget;

2. Calculate net benefit;
3. Carry out dominance analysis; and
4. Estimate the ROR.

These steps are discussed in the following sections.

Estimation of Rate of Return (ROR)

Step 1: Calculation of Net Benefit

As discussed earlier, the technique we will use in computing net benefit is partial budgeting. In order to prepare a good partial budget we need to have:

- Detailed understanding of farmers' objectives, practices, resource use pattern, constraints., etc.;
- Some understanding of fundamental concepts and principles of economic theory, e.g., profitability, risks, opportunity cost, scarcity of resources, concepts, etc.;
- Good judgement and common sense. Educated guesses are always better than ignoring a cost or a benefit. One should remember that:

  a) All sources of benefits and costs to farmers should be brought into the analysis
  b) The realism of the cost and yield assumptions are as important as the type of analysis chosen; and
  c) The partial budget will not give us the net effects. It only gives us the change on net benefit.

In order to construct a partial budget one should measure:

1. The benefit of different treatments; and
2. Costs that vary across the treatment.

Estimation of Gross Field Benefits

In estimating the Gross Field Benefits, the following steps should be followed:

1. Identify the source of benefits:

   a) Direct benefits - Main products
   - By-products

   b) Indirect benefits - For instance legume crop can fix nitrogen, which will improve the yield of the following crop. Therefore, the benefit to following crop should be included in the analysis.

2. Quantify the benefits derived from the technology or treatment

   a) Estimate the yield;
   b) Estimate the yield adjustment coefficient;
   c) Calculate the adjusted yield; and
   d) Estimate the unit value of the product.

Considerations *involved* are:

- Formal market price or informal market price?
- Market price or price received by the farmer?
- Seasonal variations in price?

To avoid confusion calculate and use the field price (see Box 31.5).

3. Calculate the gross field benefit (GFB): *GFB =Adjusted yield x field price*

Estimation of costs

Here we will have to estimate the total costs that vary across treatments, and in doing so we use the following procedure:

1. Identify and list the input items that vary across treatments.
2. Quantify the level of input in each treatment.
3. Estimate the unit price of input. Once again we use the field price for input.

Field Price of an input is the total value that must be given up in order to bring an extra unit into the field. Depending on the situation one could either use the money field price or opportunity field price. Money field price is used when the input is purchased in the market place.

Monetary Field Price = Purchased Price + Marketing Cost

Opportunity Field Price is used when the input is supplied by the farmer and represent the value of input in its best alternative use.

Note: Market price of an input is always *less than the real cost of the* input.

Estimate the Field Cost:

Field Cost of any input = Field Price of that input x *the Quantity of that input.*

Calculation of Net Benefit (NB)

Net Benefit= Gross Field Benefit - Total Cost(s) that vary across treatments.

Step 2: Dominance Analysis

Calculation of net benefit for each treatment is only an intermediate step in the economic analysis of agronomic data. The treatment with the highest net benefit does not always give the best recommendation. The net benefit calculations also do not explicitly treat some crucial aspects of small farmer's conditions, namely scarcity of resources and risk.

In order to include these two aspects which are crucial in small farmer decision making, one has to perform a *marginal analysis.* The marginal analysis can be made more efficient by an intermediate step known as *dominance analysis.* This intermediate step enables us to discard unprofitable treatments from the total set of treatments where treatments are of a continuous variable, as in fertiliser level trials.

Dominance analysis divides treatment set into two categories namely *dominated* and *dominating* treatments. A dominated treatment has lower net benefits and higher costs that vary than other treatments in the experiment. Dominated treatments need not be considered further in the analysis. One could perform dominance analysis using one of the two approaches described below:

1. Net Benefit Curve; and/or
2. Tabular Method.

Net Benefit Curve

A *Net Benefit Curve* could be drawn for any factor. A Net Benefit Curve shows the relationship between the level of input (labour in man-days or total cash outlay) and the corresponding net benefit from the alternatives.

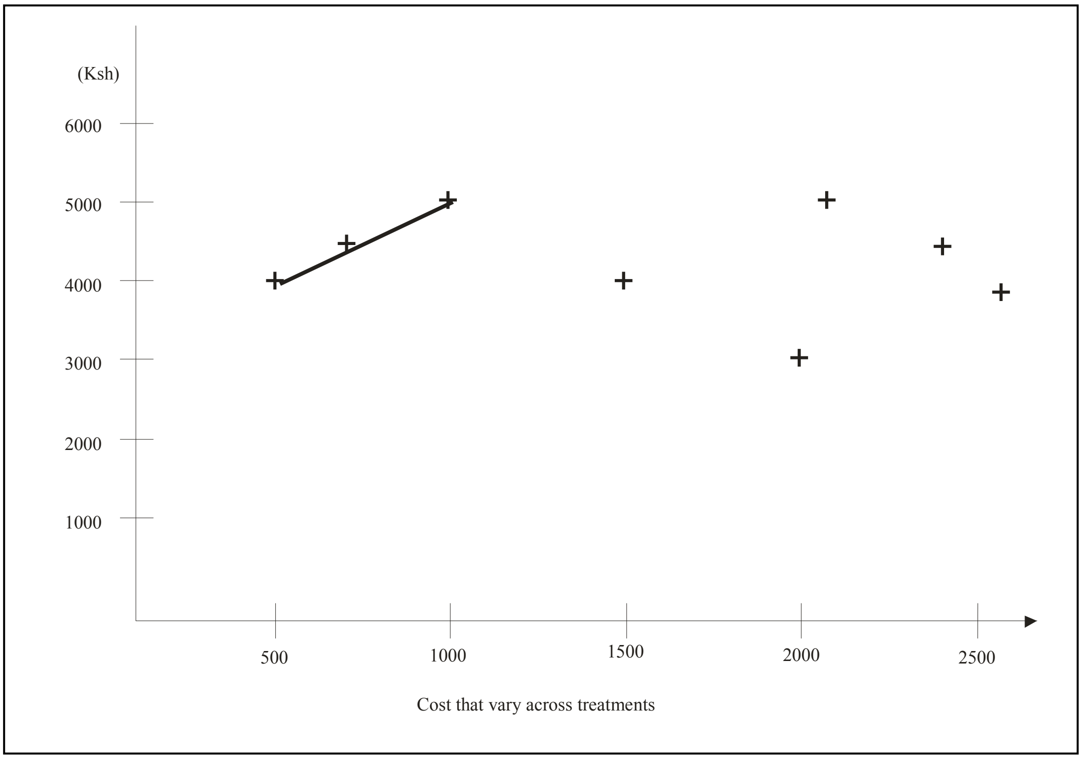
In order to construct a Net Benefit Curve you need to plot each treatment on a graph. The vertical axis represents the net benefits and the horizontal axis represents the cash outlay/labour input cash).

Assuming the factor under consideration is cash, begin with the point that corresponds to the least expensive treatment and draw a line to the point that represents the next expensive treatment. However, only an upward sloping line is allowed. The non-dominated treatments will be on the Net Benefit Curve but dominated treatments will be below the curve. In other words, the treatments, or choices which are not dominated when connected together, form the Net Benefit Curve. (see Figure 31.1).

The alternatives or treatments, which are falling below the Net Benefit Curve, are known as dominated alternatives, because for each of these treatments there is another alternative with a high net benefit and lower variable cost. Under normal circumstances a farmer will tend not to choose one of the dominated alternatives.

The dominated alternatives are eliminated from further analysis and non-dominated alternatives are used to compute the Marginal Rate of Return (MRR).

Figure 31.1: Net Benefit Curve



Tabular Method

The steps involved in the *tabular method* are:

1. List all the alternative treatments from highest to lowest net benefit; i.e., rank the treatments by net benefits.
2. Start from the top: identify and eliminate dominated treatments, i.e., eliminate any treatment (assuming cash as the limiting factor) which has a Total Cost that Vary (TCV) equal to or higher than the treatments above.
3. Use the dominating treatments for marginal analysis.
4. In computing MRR always start from the bottom of the table.

Illustrative example:

Based on nitrogen (N) by Density (D) experiments, all from one recommendation domain, the following data were obtained. Perform a dominance analysis.

Use both methods, i.e., net benefit curve and tabular method.

Table 31.1: Data from the Nitrogen by Density Experiment

Treatment	Net benefit Ksh/ha	Total cost that varies Ksh/ha
N_0D_0	3670	670
N_0D_1	4963	830
N_0D_2	5870	990
N_1D_0	3984	1373
N_1D_1	4877	1533
N_1D_2	4717	1693
N_2D_0	3174	2074
N_2D_1	4758	2234
N_2D_2	4075	2444

Dominance Analysis using Tabular Method

Step 1: Rank Net Benefits

Treatment	NB Ksh/ha	TCV Ksh/ha
N_0D_2	*5870*	*990*
N_0 D_1	*4963*	*830*
N_1 D_1	*4877*	*1533*
N_2D_1	*4758*	*2234*
N_1 D_2	4717	1693
N_2D_2	4075	2444
N_1D_0	3984	1373
N_0D_0	3670	670
N_2D_0	3174	2074

Step 2: Identify and eliminate dominated treatments

Treatment	NB Ksh/ha	TCV Ksh/ha
N_0D_2	*5870*	*990*
N_0 D_1	*4963*	*830*
~~N_1 D_1~~	~~*4877*~~	~~*1533*~~
~~N_2D_1~~	~~*4758*~~	~~*2234*~~
~~N_1 D_2~~	~~*4717*~~	~~*1693*~~
~~N_2D_2~~	~~*4075*~~	~~*2444*~~
~~N_1 D_0~~	~~*3984*~~	~~*1373*~~
~~N_0D_0~~	~~*3670*~~	~~*670*~~
~~N_2D_0~~	~~*3174*~~	~~*2074*~~

The remaining dominating treatments are N_0D_2, N_0D_1, and N_0D_0

Dominance Analysis - Using Net Benefit Curve

As discussed earlier, in a Net Benefit Curve the vertical axis represents the net benefit of various treatments and the horizontal axis represents the corresponding total cost that vary or cash outlay for the corresponding treatment. First plot all points in the space. Remember the rule, start from the least cost treatment and only positive steps are accepted. The least cost treatment is $N_0D_{0,}$ the next expensive treatment is N_0D_1, the slope is positive so connect N_0D_0 to N_0D_1. The next most expensive treatment is N_0D $_2$ and N_1D_0, the slope is positive, so connect N_0D, to N_0D_2. The next expensive treatment is N0D1, but when we connect N_0D_0, and N_1D_0, the slope will be negative. This is the same for all other treatments in relation to N_0D_2. When you connect N_0D_0, N_0D_1, and N_0D_2, you will get the Net Benefit Curve. All three treatments, which lie on the Net Benefit Curve, are dominating treatments. This is the same result we obtained with the Tabular Method. Those treatments which lie below the NB curve are dominated treatments.

Convex and non-convex net benefit curve

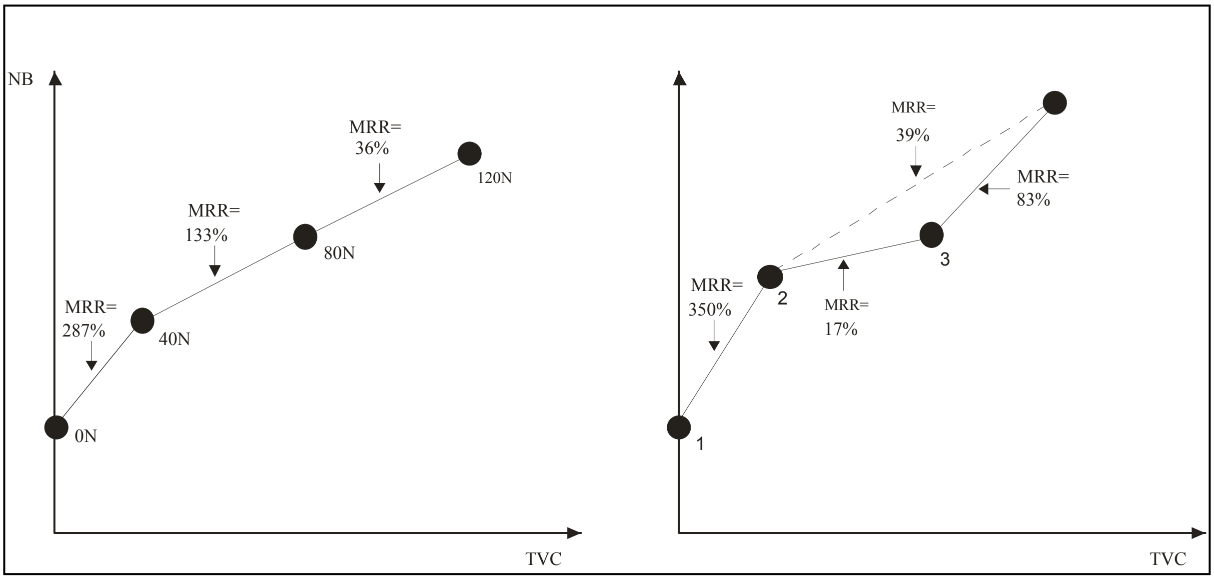
In a convex NB curve as shown in Figure 31.2, the MRR will continuously decline as we move along the response surface or the Net Benefit Curve. Here the decision making process is less complicated, but if the NB Curve is not convex as shown in Figure 31.2, then extra care is required for interpretation. If, as you move along the curve in the direction of increasing net benefits, the MRR falls below the minimum rate of return, but a subsequent MRR is above the minimum rate, then an extra step must be taken in the analytical process.

The Rate of Return between the last acceptable treatment and the next treatment associated with a MRR above the minimum rate of return must be calculated. A *residual analysis* will show that this is the right decision to make.

Limitation of Dominance Analysis

If the treatments are *mutually exclusive* one cannot use dominance analysis. Dominance analysis is very useful for levels experiments / deterministic type of trials.

Figure 31.2: Convex NB Curve   Figure 31.3: Non-Convex NB Curve



Marginal Rate of Returns Computation

The Marginal Rate of Return (MRR) of any factor is defined as the increments in Net Benefits (NB) divided by the increments in the level of that limiting resource, or factor, as one moves from one treatment to the next, expressed as a percentage (cash), or as returns per unit of physical input (labour).

For moving from treatment A to treatment B:

Error! Bookmark not defined. $$MRR_{A \to B} \frac{\Delta Net\ Benefit_{A \to B}}{\Delta Level\ of\ input_{A \to B}} \text{(as \% or \$ per Manday)}$$

where: Δ is "change in" MRR for cash (in percentage term):

$$MRR_{A \to B} \frac{\Delta Net\ Benefit A \to B}{\Delta Total\ Cash\ Outlay\ that\ vary_{A \to B}} \times 100\%$$

Error! Bookmark not defined.

MRR for labour:

$$MRR_{A \to B} \frac{\Delta Net\ Benefit_{A \to B}}{\Delta Labour\ Input_{A \to B}} \text{(\$ per man day)}$$

It should be noted that:

1. MRR does not measure the returns corresponding to a single treatment, but rather to the returns from a change from a less expensive/less labour intensive to a more expensive/more labour intensive treatment. The issue of labour saving technology must be treated differently.
2. The slope of the Net Benefit Curve is a measure of MRR.
3. Calculated MRR should be compared with the *best* alternative rates of returns for that resource in that particular system in order to make a final decision.
4. As a general principle, in calculating net benefits, do not include the cost of the factor whose returns we are going to estimate.

Computation of MRR for Cash

Steps involved in comparing MRR for cash are:

1. Construct a partial budget;
2. Compute the NB but charge no cost to cash outlay; (NB *equals* Gross Field Benefit *minus* all costs that vary across treatment excluding cost of cash)
3. Perform Dominance Analysis;
4. For dominating treatments calculate MRR using the following tabular format:

Alternative treatments	T. Cash Outlay	NB for that treatment	* ΔNB	Δ Cash outlay	$MRR = \frac{\Delta NB}{\Delta Cash\ Outlay} x100\%$

*Δ means incremental change or difference

5. Consider the Net Benefit Curve (resulting table from dominance analysis) beginning from the least expensive treatment (lowest cash outlay), calculate the MRR that is earned when moving to the next treatment of the Net Benefit Curve;
6. Compare this Rate of Return with the rate that farmer's investments capital can realise in alternative activities or minimum acceptable rate of return. As long as the estimated MRR is greater than the current rate received by the farmer, then this change is accepted; and
7. Each succeeding change is evaluated in the same way. Keep accepting changes until MRR is equal to the minimum acceptable rate of return.

Remember for economic optimum $\frac{MVPx}{Px} = 1 \text{ or } MC = MR$

Where MVP is the Marginal Value Product of any factor X, and P_x is the price of that factor, MR is the Marginal Revenue, and MC is the Marginal Cost of the output.

In sum, the researchers are asked to consider each increment in cash cost separately and they should keep accepting changes until MRR is equal of the cost of capital (interest rate or alternative rates of return) with due allowance for risk.

Example:

Let us consider the earlier example. The current rate of return for farmers' investment (or minimum acceptable rate for the farmer) is 40%. Estimate the MRR for the cash invested. How would you use this information in decision making?

Treatment	NB Ksh/ha	TVC Ksh/ha	MR
$N_0 D_2$	5870	990	
		} →	567
$N_0 D_1$	4963	830	
		} →	808
$N_0 D_0$	3670	670	

Let its consider treatments N_0D_0 and N_0D_1 N_0D_0 is the least cost treatment.

The change in the NB for the treatments N_0D_0 and N_0D_1 , is Ksh 1,293 (4,963-3,670). The change in capital outlay, i.e., additional expected investment by farmer, is Ksh 160 (830-670).

The MRR for changing from N_0 D_0 to N_0 D_1:

Error! Bookmark not defined. $= \frac{\Delta\ Net\ Benefit}{\Delta TCV} \times 100 = \frac{1293}{100} = 808\%$

The minimum acceptable rate of return for the farmer is 40 percent. The estimated Rate of Return =808% which is greater than the minimum acceptable rate of return. Therefore, it makes economic sense (risk is generally included in the minimum acceptable return) for the farmer to undertake this investment.

Now let us consider the treatments N_0 D_1 and N_0 D_2.

The change in NB for moving from N_0D_1 to N_0 D_2 is 907 (5870-4963) and the corresponding change in capital outlay is 160 (990-830).

The MRR for this change is: **Error! Bookmark not defined.** $\frac{907}{160} \times 100$

MRR for moving from N_0 D_1 to N_0 D_2 = 567%

This estimated rate of return is greater than the minimum acceptable rate of return of 40, therefore, it is profitable for the farmer to change from N_0 D_1, to N_0 D_2.

Computation of Rate of Return for Labour

The steps involved in computing MRR for labour are:

1. Construct a partial budget;
2. Calculate net benefit. In calculating TCV include cost of capital but exclude the cost of labour. NB = Gross Field Benefit - all money costs that vary across treatments (make sure that you include the cost of capital but not the cost of labour)
3. Perform dominance analysis; and
4. Calculate MRR.

Treatments	Labour inputs Person-days	NB	Δ NB	Δ Labour input	MRR for labour $\frac{\Delta\ NB}{\Delta\ Labor\ input}$

$$MRR\ for\ labour = \frac{\Delta NB\ (\$\ per\ person\ day)}{\Delta Labour\ input}$$

One could easily select the treatment which gives the highest returns to the last increment of labour used in the production process.

In interpreting labour saving technology, the indirect benefits are much more important. This technology may not have an effect on the yield but may reduce the cost (reduction in labour inputs used). Under such circumstances a minimum cost analysis is the most appropriate technique to be used. This type of labour saving technology is useless unless the labour could be used productively in some other activity at the peak labour period.

This approach can also be used to compute the rate of returns for labour at critical periods only. Remember the opportunity cost of farm labour is not fixed and vary depending on the time of the crop cycle.

Criteria for Selection

Economic Evaluation of a technological component is determined by 2 main factors:

1. Profit
2. Risk

In addition, due consideration also should be given to *system compatibility.*

Using Profit Alone

The practice chosen as best is usually the one with the highest net benefit per unit of most scarce resource. The most critical factor in the production process is determined by the system under consideration.

If labour is the most limiting factor then under normal circumstances: MRR > the current rate of return for labour or the returns from the best competing alternative

Then accept the technology!

If cash is the limiting factor: MRR for cash is > the Minimum Acceptable Rate of Return

Then accept this technology!

If the estimated MRRs are less than the minimum acceptable rate of return, the technology is not economical. In this situation, consideration is often given to adjusting the technology so as to improve its economic performance.

The minimum rate of return should cover:

- Direct cost of cash;
- Risk premium; and
- Provide some incentive (management) for the producer/farmer.

The maximum economic limit on input use is more meaningful to a farmer with abundant capital or credit. At this level the farmer makes more net income even though the efficiency with which s/he is using her/his capital and inputs is less than the maximum possible. To be acceptable, a new technology needs to be:

- At a cost which the target group of farmers can handle;
- Competitive with the present options that the farmers have for spending their cash; and
- Low risk of losing the cash investment.

Risk analysis

Need for Risk Analysis

Risk is present when the outcome of the intervention (result) is not known with certainty. For example, experimental results indicate a range (distribution) of yield obtained from various sites (locations) at different time periods (year to year variation). Not al I farmers obtain the same yield in all sites at all times. There is not one yield level (singe value) to realise but rather a range of yields, but we do not know for sure which will be realised at the farmer level of output. The marginal analysis discussed in the previous sections use an average of those yields to calculate the net benefits.

From experience we know that some treatments lead to larger yields on average but are highly variable (more risky and less stable). Other treatments may result in lower yields on average but with smaller range of variation (less risky or more stable). If farmers did not care about risk (risk neutral) then variability in yields does not matter. However, small holder farmers generally care about stability and level of returns. They are risk averse and they prefer less risk as well as higher returns. Therefore, in the minds of the farmers, a treatment that combines both desirable properties (less risky or stable as well as higher returns) dominates. Most of the times there is a trade-off between *higher* returns and risks. The choice then depends on the degree of risk aversion of the farmers. The basic questions are:

How much risk can a farmer accept in exchange for larger benefits on average? Or

How much gain in average benefits is s/he willing to give up for more stable or assured returns?

It is difficult to measure (remember that there are techniques) the degree of risk aversion or farmers' attitude towards the risk, but we need to provide for variability (risk) in our analysis as risk matters to the farmers.

Sources of Risk

Risk/uncertainty confronting farmers can originate from various sources. Two of the most common risks confronted by farmers are:

- Uncertain yields - largely due to natural factors such as rainfall, drought, frost, pest, diseases, etc. These conditions are unpredictable and beyond the farmers' control. Remember farmers can develop strategies to handle these variations. For example regular irrigation, variation in sowing date, short maturing and resistant varieties, use of pesticides and insecticides, etc.
- Market risks
  - variability in input and output prices.
  - unreliable supplies of inputs.

Techniques used in handling risk

If the probability of occurrence of each state of nature or incidence of changing factors is known, then the risk factor can be incorporated in the quantitative analysis. Unfortunately in most cases this information is not available. One can use subjective probabilities for some events. Once again we are looking for some simple technique. In performing economic analysis of technologies very often one of the following approaches can be used to handle risk:

- Minimum returns analysis;
- Sensitivity analysis; and
- Risk discounting.

These simple techniques are discussed in the following sections.

Minimum Returns Analysis

This approach compares average of the lowest net benefits for each non-dominated treatment. The simple rule of thumb is to look at the worse 25% of the cases for each treatment and compare this with the farmers' technology. The steps involved in Minimum Returns Analysis are:

1. Calculate net benefits at each location for each treatment. This step is not time consuming or difficult as it only involves changing the yield obtained in estimating Gross Field benefits. The total cost that vary will remain the same as it deals with all the same treatment. Select the lowest 25% cases in terms of NB for each treatment.
2. Compute and compare the average net benefit for the lowest 25% cases for each treatment with the NB obtained with the farmers' treatment.
3. If the average of lowest NB of new technology is higher than the average of lowest NB for farmers practice, i.e., even in worse cases the recommendation does better. In this case the new recommendation dominates, and the technology can be recommended.
4. If the average for recommendation is lower than that of the farmers practice then we need to weigh gains in overall average (expected NB) against probability of lower yields in cases of poor performance, e.g., risk. Estimate how much more risk does the recommendation add to farmers practice (difference in average of lowest 25%) compared to how much gain in NB expected on average from that innovation.

Sensitivity Analysis

Often price variations can be handled through what is known as the Sensitivity Analysis. Sensitivity Analysis is simply redoing the marginal analysis with alternative prices. Sensitivity Analysis is also known as Stability Analysis. Since experimental programs usually last more than one year and prices vary over time, a common, question often being asked is as to which costs or prices to use in economic analysis. In a sense, the Sensitivity Analysis tests the ability of a recommendation to withstand price changes (both inputs and products). With the structural adjustment programs subsidies and price control measures have been removed in many countries. Under these conditions though the agronomic relationship does not vary, the appropriate economic recommendation may be different.

Sensitivity Analysis is also to provide for errors in estimating opportunity costs, for example opportunity cost of labour or non-traded products. Here one could test the results over a range of rates or prices.

Thus, Sensitivity Analysis serves as a reminder that farmer recommendations may change as prices change. The agronomic data stay the same if the biological environment does not change. However, the economic interpretation of the same set of data will change as the economic environment change. Therefore, there is a need for continuous review of recommendations in the light of changing prices. The Sensitivity Analysis can be performed for both variations in product prices (Net Benefit) as well as input prices (Total Costs that Vary).

Steps involved in Sensitivity Analysis are:

1. Construct and perform a marginal analysis with the most likely price (or current market price);
2. Repeat the analysis with a range of prices - normally one price that is lower than most likely price (say half of the likely price) and another which is higher than the most likely price (say double); and
3. Compare the results against the minimum acceptable rate of return.

Note: The minimum acceptable rate of return should include cost of capital plus some allowance for risk and management.

Example

You are given the following information for a fertiliser experiment involving 3 treatments (ON, 40N, 80N). The minimum acceptable rate of return for the farmers for this investment is 50%. Given unreliable rainfall, application of fertiliser by farmers in this production system is considered to be risky. It is anticipated that the fertiliser price is likely to vary.

Assuming two scenarios, an increase in price of 50 and 250%, comment on the stability of the recommendation with respect to fertiliser price.

	0N	**40N**	**80N**
Adjusted yield (Kg/ha)	1,500	4,000	7,000
Gross Field Benefit (@ 10 Ksh/kg of maize)	15,000	40,000	70,000
Cost of fertiliser (@ 100 Ksh/kg N)	0	4,000	8,000
Application cost	0	200	300
Total costs that vary (Ksh)	0	4,200	8,300
Net Benefit	**15,000**	**35,800**	**61,700**

For this base scenario*:*

Error! Bookmark not defined. $$MRR_{N_0 \rightarrow N_{40}} = \frac{(35{,}800 - 15{,}000) \times 100}{4{,}200} = 495\%$$

$$MRR_{N_{40} \rightarrow N_{80}} = \frac{(61{,}700 - 35{,}800) \times 100}{8{,}300 - 4{,}200} = \frac{25{,}900 \times 100}{4{,}100} = 632\%$$

Since the minimum acceptable rate of return for cash investment is only 50%, both treatments are economically attractive, stable, i.e., the treatment can be recommended.

Assume that the price *of* fertiliser has increased by 50%. Under this assumption the partial budget will look like the following:

	0N	**40N**	**80N**
Adjusted yield (Kg/ha)	1,500	4,000	7,000
Gross Field Benefit (@ 10 Ksh/kg of maize)	15,000	40,000	70,000
Cost of fertiliser (@ 100 Ksh/kg N)	0	6,000	12,000

Application cost	0	200	300
Total costs that vary (Ksh)	0	6,200	12,300
Net Benefit	**15,000**	**33,800**	**57,700**

For this scenario:

$$MRR_{N_0 \rightarrow N_{40}} = \frac{(33,800 - 15,000) \times 100}{6,200} = 303\%$$

$$MRR_{N_{40} \rightarrow N_{80}} = \frac{(57,700 - 33,800) \times 100}{12,300 - 6,200} = \frac{23,900 \times 100}{6,100} = 392\%$$

Since the minimum acceptable rate *of* return for cash investment is only 50% both treatments are still economically attractive, i.e., stable, and can be recommended.

Assume that the price *of* fertiliser has increased by 2.5 times, i.e., 250%. Under this scenario, the new partial budget will look like the following:

	ON	40N	80N
Adjusted yield (Kg/ha)	1 500	4 000	7 000
Gross Field Benefit (@ 10 Ksh/kg *of* maize)	15 000	40 000	70 000
Cost of fertiliser (@ 100 Ksh/kg N)	0	10 000	20 000
Application cost	0	200	300
Total costs that vary (Ksh)	0	10 200	20 300
Net Benefit	**15 000**	**29 800**	**49 700**

For this scenario:

$$MRR_{N_0 \rightarrow N_{40}} = \frac{(29,800 - 15,000) \times 100}{10,200} = 145\%$$

$$MRR_{N_{40} \rightarrow N_{80}} = \frac{(49,700 - 29,800) \times 100}{20,300 - 10,200} = \frac{19,900 \times 100}{10,100} = 197\%$$

Summary Table Stability Analysis for Fertiliser price

Treatment	MRR for different Fertiliser Prices (Percentage)			Stability of the recommendation
	Base	50% increase	250%	
	495	303	145	Stable
	632	392	197	Stable

The above analysis indicate that even with *250%* increase in fertiliser price the two treatments are economically viable, i.e., stable, and can be recommended.

A similar analysis can be performed for variation in maize prices as well as wage rate for labour.

Risk Discounting

This is simply a matter of discounting the rate of return for risk. This is done by adding a risk premium to the cost of capital in estimating the Minimum Acceptable Rate of Return (MARR) for the farmer. The risk premium depends on the nature of the technology, which depends on the subjective judgement of the research team. If the anticipated risk is high, then the benefits are highly discounted by adding a much higher risk premium in MARR.

As a rule of thumb, the average acceptable rate of return should be, at the very least, 20 percent above the direct cost of capital. Remember: the cost of capital may vary from farmer to farmer and may also depend on the source of capital.

The following points should be noted:

- In general there is very little point in doing economic analysis of results that do not make agronomic sense.
- If the results are not significant at the conventional level (0.01, 0.05, 0.10 per cent), look for patterns of response. If the differences are larger in relation to farmers yield, and consistent across sites (even when not statistically significant, i.e., consistency in performance across location), then this deserves some specific attention. As a general rule, perform an economic analysis.
- If higher levels of output are attained with the same level resource use, proceed with marginal analysis.
- If the same level of output is attained with lower level of resources (lower costs) then, there are still net gains to be captured from saved cost.
- If there is no statistically significant difference in yields between treatments, then look for:
  - Lower cost alternatives;
  - Indirect benefit;
  - Total production of the system; and
  - Changes in resource distribution.
- Results of the statistical analysis to a large extent dictate the parameter to be used, and the way in which partial budgets are constructed.

Cost of Capital

One of the key aspects in the risk discounting procedure is the estimation of the direct cost of capital. The cost of capital depends on the source of capital as well as the attractiveness of the alternative investment as shown in .Box 31.7 The direct cost of capital is the earnings given up by not using the money or the return generated from the best alternative case where the capital is already being employed. It is important to remember that the actual cost of capital to a fanner is not the same as the market interest rate.

Example 1: A farmer borrowed Ksh. 3,000 for eight months at an annual interest rate of 20%. Besides interest the fanner paid a service charge *of* Ksh. 100 and s/he had Ksh. 140 of personal expenses relating to the loan. *What is the cost of borrowed capital?*

Box 31.7: Source and Cost of Capital

Source	- Alternative Investment

• Own	- Use in Agriculture - Others
• Borrowed	- Institutional - Non-Institutional

Annual interest costs $= \frac{3{,}000 \times 20}{100} = Ksh\ 600$

The interest cost for eight months $= \frac{600 \times 8}{12} = Ksh\ 600$

Service charge on loan = Ksh. 100

Personal expenses = Ksh. 140

Therefore the total cost = 400 + 100 + 140 = Ksh. 640

Cost of borrowed capital $= \frac{640 \times 8}{3{,}000} = 21{,}3\%$

Example 2: A farmer borrowed Ksh. 2,000 from a village moneylender. She does not have to pay any service charges or personal expenses, but only the 10% interest per month. *"What is the farmer's cost of capital if the loan runs for seven months?*

$$Interest\ per\ month = \frac{10 \times 2000}{100} = Ksh200$$

$$Interest\ \ charges\ \ for\ 7\ months = 200 \times 7 = Ksh\ 1{,}400$$

$$The\ cost\ of\ capital = \frac{1{,}400 \times 100}{2{,}000} = 70\%$$

Minimum Acceptable Rate of Returns

The Minimum Acceptable Rate of Return (MARR) is only an estimate and it must be inferred from an estimate of the cost of borrowed capital. We need to be very realistic in making such estimation. The MARR should include the direct cost of capital, plus some allowance for risk (and management).

The MARR is influenced by three factors:

1. The type of technology under consideration:
   - Whether it involves a major /minor change from the current practice;
   - Likelihood of failure (loosing a crop) and frequency; and
   - Amount of cash involved.
2. The cost of borrowed capital. This depends on the source and alternative use as discussed earlier.
3. The length of the enterprise cycle.

These factors should be carefully considered in estimating the MARR.

Box 31.8: Steps in the Economic Analysis of Trial Data

The approach used in economic analysis is determined by the results of the statistical analysis.

STEP 1: CONSTRUCTION OF BUDGET

1. Determine which inputs vary across treatments and obtain the amount and cost/price data for each of these inputs.
2. Adjust the yields. (The yield adjustment coefficient used depends on the type of trial).
3. Calculate field price prices/costs. (Marketed and non-marketed)
4. Calculate Gross Field Benefits (include by-products) GFB =Adjusted yield Field Price
5. Calculate cost of inputs that varies across treatments.

STEP 2: ESTIMATING RETURNS TO THE SCARCE FACTOR (S)

1. Calculate the Net Benefit (NB). NB = GFB - sum of cost of all inputs that vary across treatments[17]
2. Estimate the amount of scarce factor invested in each treatment.
3. Perform dominance analysis to eliminate treatments that need not be considered further in analysis.
4. Do a marginal analysis between pairs of treatments

$$MRR_{A \to B} \; \frac{\Delta NB_{A \to B}}{\Delta Amount\ of\ Scarce\ \ factor_{A \to B}}$$

Expressed as a percentage or in physical units.

5. Compare the marginal returns per unit of the scarce factor (other reduction in cost by saving one unit of the scarce factor) with the cost of that factor (either direct cost or opportunity cost) to decide whether a change from treatment (a) to treatment (b) is acceptable.

NOTE: ECONOMIC CRITERIA

Maximise the Net Return per unit of scarce resource. Once MRR is computed, rank them. Select the treatment(s) with the marginal rate of return greater than Minimum Acceptable Rate of Return. Upper limit is when the MRR is equal to the Minimum Acceptable Rate of Return.

FURTHER STEPS TO BE CONSIDERED

a) Combine with risk analysis:

- Stability analysis/sensitivity analysis;
- Minimum returns analysis; and
- Risk discounting.

b) Check for Systems Compatibility

If a technology or technological components pass all these tests simultaneously, then the chance that this technology will be accepted by the target group of farmers is very high.

Of course, consider farmer assessment also before a recommendation is made.

KEY REFERENCE

CIMMYT. (1988) *From Agronomic Data to Farmer Recommendations: An Economics Training Manual*. CIMMYT Economic Programme, Mexico, D.F: CIMMYT.

[17] In computing the costs exclude the cost of the scarce factor on which marginal analysis is to be performed.

METHODS OF OBTAINING ESTIMATES

Introduction

Data is needed for both ex-post and ex-ante impact assessment. Exposed assessment is often based on observations, whereas ex-ante assessment is based on expected values. These expected values are based on the past experiences of the individuals. There are a large number of ways of obtaining estimates of the probabilities, benefits, and cost of projects for use in project ranking models or formulae. The various methods available for obtaining estimates are discussed in this chapter.

Methods of Obtaining Estimates

- The available methods are classified as follows:
- Personal opinion;
- Group opinion. This method includes:
  - Opinion polls;
  - Informal one to one conversion;
  - Committee meetings, conferences, seminars;
  - Nominal group technique; and
  - Delphi technique.
- Simulation approach. This includes the programming approach.

Personal Opinion

- Estimates based on their own personal judgement;
- If judgement is informed and professional, then estimates based on opinion can be useful; and
- Individual opinions are generally not as reliable as group opinions. Individual opinions tend to vary widely, which means that any one opinion has a high risk of being wrong.

Group Opinion

A group consensus is usually achieved through extreme views cancelling one another with the result that the group opinion is fairly reliable.

Methods of obtaining group opinion

The opinion of a group can be obtained through a series of informal one-on-one conversation with individual members of a group, through a committee meeting or a thorough or more formal conference or seminar.

One-on-one approach

Fail to generate true group interaction and more seriously, is very susceptible to bias on the part of the person obtaining the information.

Opinion polls

This approach simply averages a lot of judgement of varying quality and informational backing. The approach does not produce a reasoned consensus.

Meeting of one sort or another

This method is subject to a number of pressures that distort the results. It is subject to personality-induced biases, i.e., follow the leader. A meeting could be dominated by a loquacious individual who may not be the most knowledgeable person. Frequently shy individuals will not speak up at a meeting even though he or she has key information. This is particularly true if the majority holds the contrary opinion.

Even a strong person can be intimidated at a meeting attended by management at a higher level. Personality conflicts may prevent a meaningful exchange of information in any open session. An expert who has taken a public stand on an issue may find it difficult to back off even in the light of additional information.

Nominal group techniques

This is an alternative method of obtaining group decision or value judgement. Here 5-10 group members gathered around a table to first generate and write down their individual estimates, and after feedback of the recorded estimates, the group discusses and evaluates them. Several successive iterations of individual assessments and feedback of the revised estimates then follow.

Advantages:

- Quick compared with Delphi technique;
- Provides a more direct interaction between group members; and
- Provide a greater feeling of integration and group identity.

Delphi Method

The Delphi method or technique is a formal structured means of group communications that tends to overcome the shortcoming of traditional meetings. This is a method useful for the controlled exchange of information within a group. Delphi method was developed by Rand Corporation in the 1950's to overcome some of the biases associated with opinion polls and committee methods. This method now is a standard tool whenever a consensus of experts is sought on a subject. It provides a structured, indirect, iterative consensus seeking interaction between panel members who do not confront each other around a table and are, in fact, usually unaware of the identity of the other panel members. Some of the features of the method are:

- It allows feedback of information to group members;
- It allows individuals some opportunity to assess group views;
- It allows some opportunity for individuals to make their opinions known to the group; and
- It provides relative anonymity for individuals.

The Delphi method has proved to be an effective way of combining expert opinion for technological and social forecasting purposes.

Delphi group

To conduct a Delphi experiment, a participating group and a person to serve as a monitor is needed. Characteristics of this group are:

- The group should consist of experts on the topic under discussion, i.e., people who by training, experience or position are qualified to have an opinion on the subject;
- The group should be diverse (users, extensionists, researchers and academicians);
- The panel of experts must be committed to the study and must take its job seriously;
- A panel should consist of at least ten people;
- A Delphi group need not be assembled in one location to conduct an experiment because all communication is done in writing;
- The monitor is in charge of the experiment. During the experiment, the monitor gathers and tabulates statistics, monitors responses that are generated and presents appropriate information to the group. He communicates the final outcome of the experiment to the group;
- The biggest job the monitor has is to maintain strict neutrality throughout the experiment. It is important for the enumerator to be neutral and treat the expert opinion in the same way as observed facts, to be recorded, analysed, and fed back for reconsideration, but in no way influenced, identified with, or discounted by the enumerator; and
- A good deal of preliminary work of literature search and discussion with knowledgeable individuals was necessary before preparation of the questionnaire, and selection of the panel members.

Some of the statistical terms that are used in a Delphi experiment are:

- Minimum: The smallest response;
- Median: Middle response;
- Maximum: The largest response;
- Mode: The response given more frequently.

- The first quartile: The response such that at least 25 percent of the responses are equal to it or are less, and at least 75 percent are equal to it or are greater;
- The second quartile, or median response: The response such that at least 50 percent of the responses are equal to it or greater. The second quartile or median is the middle-most response;
- The third quartile: The response such that at least 75 percent of the responses are equal to or less than it and at least 25 percent are equal to it or are greater; and
- The inter-quartile range: The range from the first quartile to the third quartile. It is the range that contains at least one half of the responses.

Another way of looking at it is to arrange the responses in order from the smallest to the largest. Then:

- Count up to one-fourth of the responses from the lower end, i.e., the first quartile;
- Then count up one-half of the responses from the lower end, i.e., the second quartile; and
- Then count up to three-fourths of the responses, i.e., the third quartile.

An Illustrative Example

A group was asked to indicate as to how long it will take to reach the adoption ceiling of a particular technology. Suppose there were 15 responses to the question as follows:

4, 6, 9, 8, 5, 2, 7, 3, 9, 6, 6, 8, 2, 5, 1

The first step is to rank them:

1, 2, 2, 3, 4, 5, 5, 6, 6, 6, 7, 8, 8, 9, 9.

One-fourth of 15 is 4 (after rounding) and the fourth response in order is 3. Thus, the first quartile is 3. In a similar way the second quartile is 6 and the 3rd quartile is 8. The inter-quartile range is from 3-8. The mode is 6 - maximum frequency. The median is 6 - middle point.

Delphi process

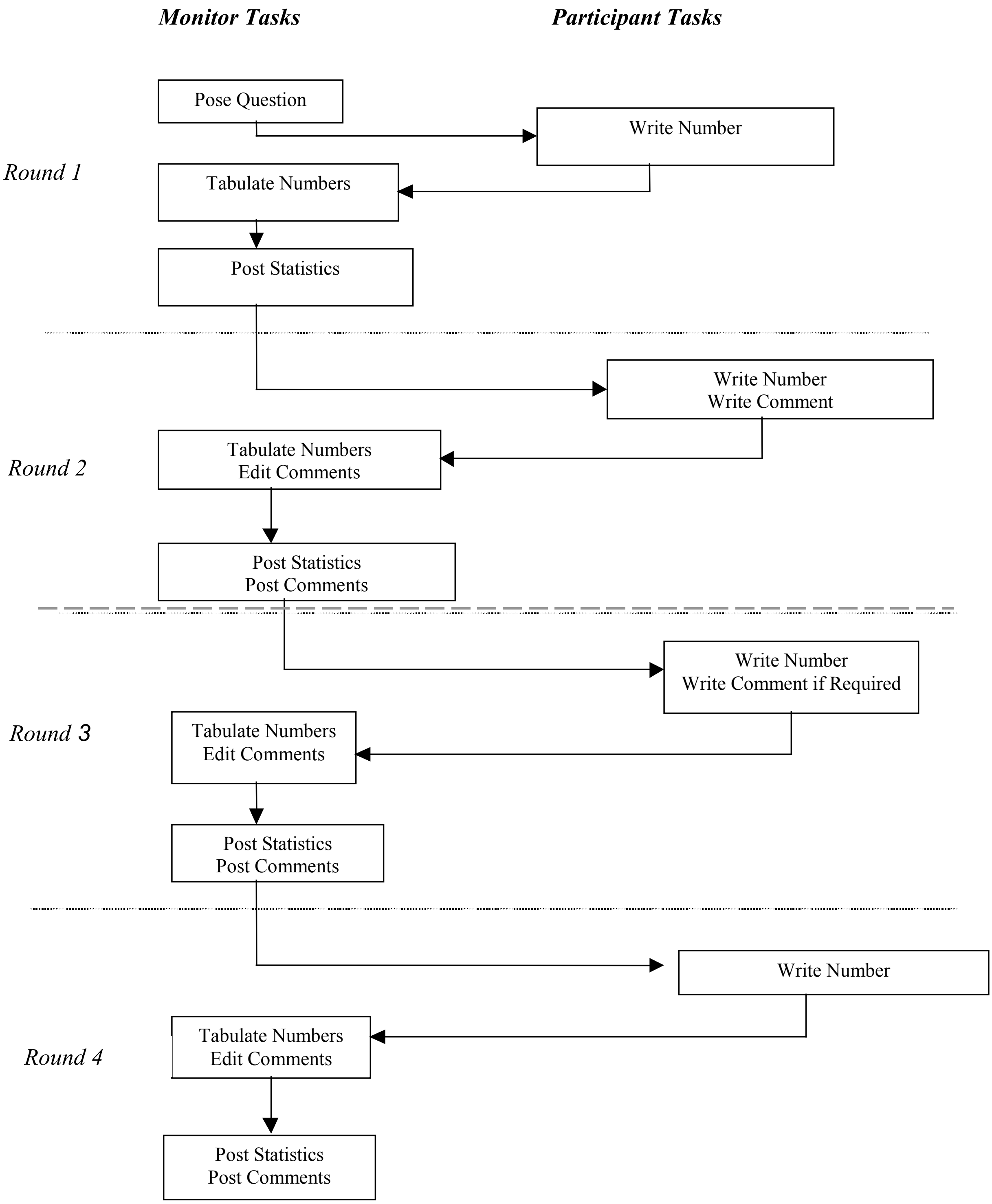
Typically the experiment is conducted in four rounds as illustrated in Figure 32.1. Each round calls for a response from each group member.

Round 1:

The monitor poses a question that requires a numerical answer. A panel of experts is asked to estimate the probabilities, magnitudes or consequences of certain events or characteristics - which will be referred to as an estimate. Participants respond to the question in writing. The responses are gathered by the monitor, tabulated and analysed. The monitor then gives the group the following information:

- The minimum response;
- The maximum response;
- The first, second and third quartiles;
- The inter-quartile range; and
- The modes.
- Summary of the Delphi technique

Figure 32.1: Summary of the Delphi Technique



Round 2:

The monitor asks each participant to make a new response to other question. The respondents will be asked to reconsider their answers and revise them as desired. If the new estimates are outside the inter-quartile range, the respondents are asked to state concisely his/her reason for this estimate. The monitor then collects a response from each participant. These responses consist of:

- The new estimate; and
- A reason for holding an extreme view if the new estimate is outside the round one inter-quartile range.

Before presenting the reasons for extreme views to the group, the monitor should edit them to make certain that they do not reveal the identity of the writer, and making sure that he is not injecting a bias. After editing the written reasons, the monitor presents them to the group. This is best done by having the statement typed so as to avoid the possibility that handwriting might be recognised.

Round 3:

Round 3 resembles Round 2 except that the reasons are now given for an estimate inside the Inter-quartile range. The panelists are invited to revise their second round estimates/response taking the minority viewpoint into account. The monitor asks each participant to:

- Make a new estimate;
- Compare the new estimate with the inter-quartile range given at the end of Round 2; and
- If the new estimates are inside the range, the participants should state why the arguments for the extreme views given at the close of Round 2 did not convince him.

The monitor collects all responses. He/she tabulates the new estimates and gives the group the same type of summary information as was presented in Rounds 1 and 2. After editing the written reasons, the monitor presents them to the group.

Round 4:

The monitor solicits the final responses from the group in Round 4. The following steps are taken:

- The monitor asks for new estimates;
- No reasons need to be given; and
- The new estimates are summarised and presented.

The median from the final response is taken as approximating the group consensus. The inter-quartile spread gives some idea of the range in which the actual answer might be found. In addition, the spread of this range gives some indication as to the degree of consensus among the group on the question. The greater the spread the less the consensus and the greater the risk associated with the median estimates.

Advantages of the Delphi technique

- Delphi is a flexible technique. Modifications can be made based on the time and money. One variant is where the enumerator/monitor obtains panel members' responses in at least one of the rounds by interviews rather than mailed questionnaires;
- Delphi method is cheaper where the experts are geographically dispersed; and
- Delphi can handle larger panels and lend itself to more detailed questionnaires.

Disadvantages of the Delphi technique

- It is difficult to assess the quality of response from a questionnaire, and to tell whether a respondent has really bothered to think about his answers; and
- Delphi questionnaires tend to impose a rigid framework upon the respondents and make it difficult for them to point out that the wrong questions are being asked.

Simulation or programming models

This is a normative approach. Potential utility of research in different areas is calculated as percentage changes in technical coefficient needed to bring about a one percent increase in net income of various rural industries. The approach provides only some of the elements required for research decisions and it may well be a useful input to the planning process. Because of the extensive data needed, this approach is used to a very limited extent.

KEY REFERENCE

Amara, R. & A.J. Lipinski. (1983) *Business Planning for an Uncertain Future: Scenarios and Strategies.* Pergamon.

ADOPTION STUDIES AND IMPACT ASSESSMENT

Introduction

The people level impact of any research activity cannot be assessed without information about the (extent) number of users and the degree of (intensity) adoption of improved techniques, and the effect of these techniques on the production costs and output. One needs to know the rate of adoption of a technology by the target group over a period of time, in order to estimate the benefit flow from the R&D investment. The adoption of any technology is determined by several factors which may not be a part of the original research activity. Often adoption surveys are carried out to assess the extent of the use of the technology by the targeted beneficiaries and then provide effective feedback to the research and development community. The purpose and the various aspects of the adoption survey are discussed in this chapter.

Reasons for Conducting Adoption Studies

There are several reasons to invest in studying the adoption of agricultural technology. These are:

- Monitoring and feedback in technology generation, i.e., improving the efficiency of technology generation;
- Assessing the effectiveness of technology transfer;
- Understanding the role of policy in the adoption of technology. Adoption studies are also useful for illustrating the degree to which acceptance of new technologies is limited by insufficient inputs, credit or marketing structure. New technology is often not adopted due to lack of input, access to credit, marketing bottlenecks, and pricing policy. These policy-related constraints can be identified through adoption surveys.

Measuring the Impact of Technology Generation and Transfer

Research and extension institutions are often engaged in a battle to maintain their budgets, and this implies the necessity for demonstrating results. Adoption studies are an important tool for measuring and assessing impact. They also provide data that can be used to estimate the return to investment in research or extension.

Monitoring changes in farming practices and assessing the adoption of new technology should be important elements of the entire research process.

Methods of Assessing Adoption

Although constant monitoring of farmers' opinions and experience is essential during the design and testing of agricultural technology, it is also necessary to carry out some sort of assessment after a new technology has been recommended or introduced. The type and timing of the assessment will depend on the purpose of the study. Several considerations are:

- An informal survey may be sufficient for analysing adoption patterns; and
- Formal surveys generate quantitative information that is useful for decision makers and are better able to explore some of the complex issues in understanding variability in adoption among farmers.

The results of a formal adoption study can be combined with other data on changes in farm production, farm incomes, or consumer going to develop a more complete study. There are also other ways of studying the spread of new technology. Data from an agricultural census may provide some idea of the degree to which farmers use a particular technology. If a new technology involves purchased inputs, for instance, surveys of input merchants may be useful for assessing the spread of technology.

Defining Adoption

What constitutes adoption? This question needs to be answered before embarking on any adoption studies. Possible adoption parameters are:

- Farmers planting a few rows of the new variety;
- Certain minimum proportion of their field with new variety;

- Crop management practices, how closely does the farmer have to follow a recommendation before being considered an adopter; and
- Fertiliser recommendation, any use can be considered adoption or do the rate and timing of application have to fall within certain limits.

Although these may seem to be definitions that can be decided after the survey is completed, they need to be discussed beforehand because they can influence the sorts of questions asked to the farmers. In defining the criteria for adoption, it is also important to remember although the recommendations may be presented to farmers as a package of several practices, some components of the package may be adopted first, others may be adopted later, and some may never find widespread acceptance. The adoption study, therefore, asks specifically about each component of the package, bearing in mind that individual components may be adopted at different times and under different conditions.

Researchers need to decide whether to assess adoption on all fields or only the largest field or on fields that have characteristics relevant to the new technology, e.g., soil conservation measures are relevant to sloping fields only. If the average rate of input application is reported in the survey analysis, it should be clearly stated if the rates are only for those farmers who use the input, or are the average across users and nonusers. Sometimes there is more than one agricultural season per year. In this case, adoption may be assessed for only the most important season or for all the seasons.

Adoption of a new technology can be defined in several ways. In all cases, the definition of "adoption" needs to be agreed upon. Sometimes it may be sufficient simply to report on the proportion of farmers using the technology (at some defined level). In other cases, the actual proportion of fields or crop area under the new technology will need to be estimated.

Describing Adoption

The logistic curve

It is useful to distinguish between adoption, which is measured at one point in time, and diffusion, which is the spread of a new technology across a population over time. Much of the literature on diffusion assumes that the cumulative proportion of adoption follows an S-shaped curve (see Figure 33.1) in which there is slow initial growth of the new technology, followed by a more rapid increase and then a slowing down as the cumulative proportion of adoption approaches its maximum (which may be well below 100 percent of farmers).

The logistics curve can be mathematically described as:

$$Y_t = K/(1 + {}^{e^{-a-bt}})$$

Where: Y_t = the cumulative percentage of adopters or area at a time *t*;
k = the upper bound of adoption;
b = a constant, related to the rate of adoption; and
a = a constant, related to the time when adoption begins

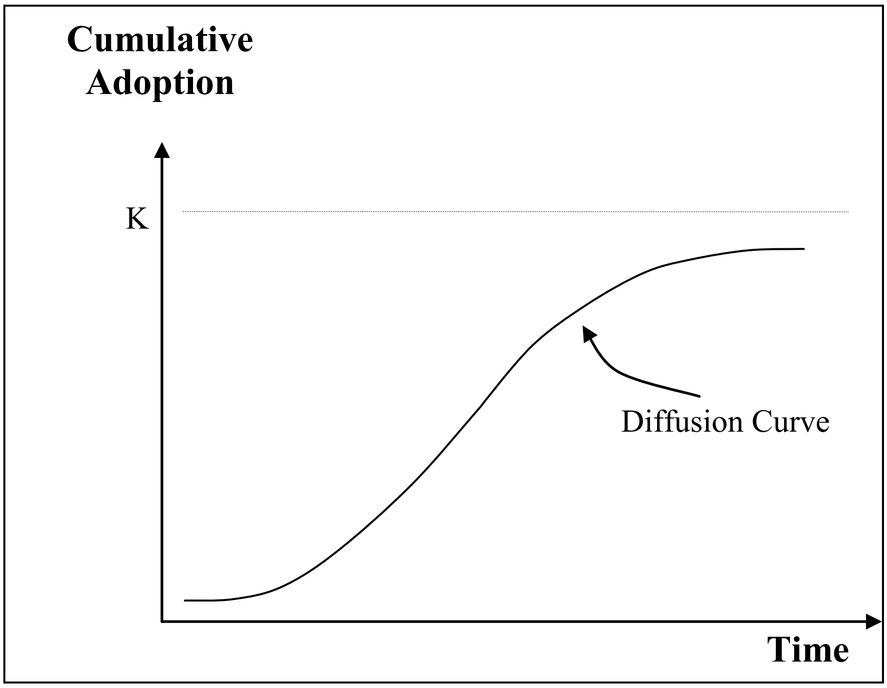
If we have sufficient observations on Y_t, we can estimate the three unknown parameters k a and b with a non linear regression.

Timeframe

It is also important to remember that not only is the diffusion of a new practice among farmers a gradual process, but that individual farmers testing of technology may follow the same type of curve. If possible, a farmer will test a new technology on a small part of the farm, and if the results are positive will gradually increase the use of the technology.

Besides looking at past patterns of adoption, it is sometimes tempting to try to assess future trends by asking farmers their plans using a technology the following year.

Figure 33.1: The Logistic Curve



Measuring Impact

If the adoption study has been done to help provide some measure of the impact of the research or extension effort, it will be helpful to convert these figures so that the actual amount of value of the increased production (or other benefit) resulting from the adoption can be estimated. If the benefits of the new technology are largely expressed as increased yield, then the first step is to estimate the yield change due to adoption. Sources of adoption information are:

- Adoption surveys;
- Farmers may be asked to estimate yields from particular fields; and
- Crop cuts as a part of the surveys.

It will be difficult to find farmers who manage comparable fields in which the only difference is the adoption of the technology under study, or to find comparable farmers who use and do not use the technology to provide firm estimates of yield differences that can be attributed to adoption. If experimental data were used, then make sure that yield estimates were obtained under a typical farmers' management, rather than the researchers' management.

Once the yield differences have been estimated, it is possible to assign a value to the increased yield and calculate the total value of increased production resulting from the adoption study area. The simplest approach is to assume that widespread adoption has not affected prices, but when this is not the case, price effects must be accounted for.

If the diffusion curve has been calculated, this can be used to estimate the stream of benefits over time. This figure will provide some idea of the value of the product of the research effort.

It may also be important to obtain an estimate of the increased income for farmers who have adopted the new technology. Such an estimate will require good data on the variable costs of the technology.

More complex questions may also be asked about the distributional impacts of a new technology. Not only is it important to understand how a new technology is used by different types of farmers, it is also important to see how the benefits of the technology are distributed among various sectors of the population. Some of the possible combinations of beneficiaries are:

- Farmers vs. consumers;
- Landowners vs. tenants vs. labourers; and
- Male farmers vs. female farmers.

The Role of Adoption Studies in Assessing the Returns to Research and Extension

One of the reasons for doing an adoption study is to provide evidence of the returns to a research or extension effort. It should be obvious that the results of a good adoption study are an essential element for a benefit - cost analysis of an agricultural technology generation program.

The survey will need to collect evidence that allows the change in technology to be attributed clearly to the research of an extension program under examination. Evidence should assure that the farmer adoption took place after the recommendation became available and evidence that the information utilised by farmers had its origin in the research or extension program

In some studies/cases it will be necessary to distinguish between returns to research and returns to extension. If a study is to estimate the returns to one or the other of these activities, particular care must be taken in separating the two, and in examining to what extent research and extension are substitutes or complements.

Survey Organisation

The following decisions have to be made before embarking on a survey:

- Researchers must carefully define the nature of the technology and changes they hope to analyse. What types of changes in farmers' practice they propose to study?
- Need to identify the audience for their study:
  - Feedback to research and extension;
  - Policy makers; and
  - Document impact of a research and extension effort.

Sampling

The aim of sampling is to provide information to improve the efficiency of research and extension activities, i.e., to study and understand the success. Sampling for the study should be undertaken with special care, avoiding biases that may show the institution in an unusually favourable light and making sure not to ignore issues that should be addressed. For instance, the adoption of a new technology may be more rapid with farmers who have better access to roads, extension services, or markets. It is important that the sampling for a study be carried out so as to avoid favouring such farmers and giving the impression that adoption is more widespread than it really is.

Sampling frame

It is important to define the population to be sampled:

- All farmers in a specified region;
- All maize/groundnut growing farmers;
- All farmers who grow at least half a hectare of groundnuts; and/or
- All farmers who participated in the special extension program.

The answer depends on the purpose of the study, but a clear definition of the population is important. This may prove to be more difficult than it sounds when considering the:

- Household;
- Special plots for specific individuals in the family; and
- Polygamous society.

Once the study population has been defined, it is necessary to identify the sampling frame. The sampling frame is constructed so that random sampling can be carried out by:

- Using maps; and
- Multi-stage sampling.

It requires careful planning especially if the first stage units (villages) are very different sizes. One should:

- Recombine the first stage units so they are roughly equivalent size; and

- Select the units, with a probability approximately equivalent to their size, and then to choose equal numbers for each sampled unit.

Sample size

Sample size depends on the:

- Nature of the study;
- Resources available; and
- Variability in the population, i.e., stratified sampling.

Sampling for comparison

In many instances an adoption study attempts to answer questions about differences in the rate of adoption between groups of farmers, e.g., participants in an extension program vs. non-participants.

Sampling fields

If the farmers are cultivating several fields, then the researchers will have to decide whether they are going to assess adoption of the technology on all of the farmers' fields, on fields with certain characteristics, or only on the largest fields. This primarily depends on the definition of adoption selected for the study. If the purpose is to inventorise the use of a particular technology, then all fields may have to be sampled. If the purpose is more to understand the context in which a technology is used, then a sub-sample of fields may be sufficient, or the farmers themselves may be the only sampling unit in which case the should be classified as adopters and non-adopters.

Timing of study

- The overall timing depends on purpose of the study:
  - Adoption vs. impact; and/or
  - Field observation.
- The best time to do an adoption study will be shortly after harvest; and in a “Normal” year.

Survey design

Both the design and the instrument used, i.e., the questionnaire, are equally important. It is very important that no leading questions are asked and so that the farmers do not feel they are being tested with regard to their knowledge and use of recommendations. The questions will be determined by the objective of the study and should include:

- Document adoption, i.e., proportion of farmers adopting technology;
- Proportion of the area;
- Production associated with new practice; and
- An understanding of why some adopted and others have not.

Questionnaire

In questionnaire development, particular attention should be given to:

- Content;
- Format;
- Open vs. closed questions; and
- Leading questions.
- Specificity:
  - Questions about adoption should be as specific as possible, e.g., do you use fertiliser? and;
  - Field, season, unit etc.

Survey implementation

Some of the issues that need to be addressed in survey implementation are:

- Pre-testing;

- Coding – Pre- vs. post coding
- Logistics; and
- Supervision.

For adoption studies to be useful, a report should be written and distributed as soon as possible.

Conclusion

In carrying out an adoption study, one needs to:

- Define precisely what technologies are being considered;
- Decide how to measure adoption;
- What timeframe is of interest;
- If the objective is to assess impact, demonstrate a connection between changes in farmers practices and the research, extension or community development efforts; and
- An adoption study is also useful for understanding the rationale behind the changes occurring at the farm level.

Several factors may influence the farmers' decision about adopting or not adopting a particular technology/technological component. In order to conduct an impact study it is important for one to have some knowledge about these factors. A summary of these factors is presented in Appendix II.

If the diffusion pattern is established, then this information can be used to estimate the stream of benefits over time. Results of a good adoption study are essential elements for a benefit-cost analysis of an agricultural technology development and diffusion program.

KEY REFERENCE

CIMMYT. (1993). *The Adoption of Agricultural Technology: A Guide for Survey Design*. CIMMYT Economics Program. Mexico, D.F: CIMMYT

NON-MARKET ENVIRONMENTAL BENEFITS AND VALUATION TECHNIQUES

Introduction

Non-market environmental benefits are typically divided into two categories: use benefits and non-use benefits. These two types of benefits and the economic techniques available for valuing the environment costs and benefits are discussed in this chapter.

Use Benefits

Use benefits are those benefits that accrue from the physical use of environmental resources such as visiting a national park, recreational fishing, etc. The benefits to productive activities, such as agriculture, forestry, or fisheries, of preserving or improving environmental amenities are also included in this category.

Non-use Benefits

Non-use benefits refer to the psychological benefits individuals may obtain from environmental resources without directly using such resources. The non-use benefits are generally classified under five types: existence value, vicarious value, option value, quasi-option value and bequest value.

Existence value

Existence value is the value obtained from the knowledge that an environmental amenity exists.

Vicarious value

Vicarious value is the value obtained from the indirect consumption of an environmental amenity through print or other media.

Option value

Option value is the value obtained by retaining the opportunity to use an environmental amenity at some future date. Option value stems from the combination of the individual's uncertainty about his or her future demand for the resource, and uncertainty about its future availability.

Quasi-option value

Quasi-option value is the opportunity value of obtaining better information by delaying a decision that may result in irreversible environmental loss. Such value may be obtained by the benefit associated with the possibility that future technologies or knowledge may enhance the value of a natural resource.

Bequest value

Bequest value is the value the current generation obtains from preserving the environment for future generations.

Economic Techniques for Valuing the Environment

A variety of economic techniques and models have been developed for assigning monetary values to gains or losses associated with changes in the availability or character of environmental amenities. These measurement techniques are classified into three groups:

- Physical linkage models;
- The related market approach; and
- Contingent valuation.

Physical linkage approach

The physical linkage approach treats environmental amenities as factors of production. Here, environmental values are indirectly estimated by attempting to establish a relationship between the physical effects of some environmental changes on human health, productivity or earnings, e.g., the effect of water pollution on the profitability of commercial fishing activity. This approach is also known as the damage cost/dose response approach. The objective is to measure the change in net benefit as revealed in market prices caused by environmental damage. Alternatively, benefits can be measured as the increased productivity attributable to improved environmental quality.

Related market approach

The related market approach uses market values to estimate indirectly environmental use benefits. The value of an un-priced amenity is inferred by using statistical analysis to examine how a change in the amenity affects the observed purchase price of related goods.

This approach includes:

- Hedonic price method; and
- Travel cost method

Using the hedonic price approach, real estate values can be examined to detect any "premium paid" for location with superior air quality, or discount for poor drainage.

Contingent valuation

The contingent valuation method relies on what people say they would buy, that is, their behavioural intention. Contingent valuation, a surrogate market approach is a method of establishing a monetary value for a good or service by asking people what they are prepared to pay for it. This method seeks to determine a level of payment acceptable to most people. It can determine a willingness to pay for a better environment or accept compensation for a degraded environment.

The travel cost, hedonic price, and contingent valuation methods are discussed in the following sections.

Travel Cost Approach

The travel cost approach is another surrogate market technique, particularly useful for assessing the economic value of natural areas or recreational areas where no price is directly charged. In this case, the willingness to pay for an environmental amenity is assumed to be measured in the costs incurred by people when travelling to chosen locations.

Travel costs from each concentric zone around the site are used as a surrogate for price, the quantity being determined by head counts of the number of visitors from each zone. The relationship between cost and visitor rates becomes a demand curve for the recreational experience which might involve a number of activities. The travel cost approach is well accepted, probably underestimating real benefits, since it does not try to establish the maximum willingness to pay.

When the survey of how frequently each person or group makes a visit to the area is taken, travelling distance and cost can be gauged. The total population in each zone must be known. From this the rate of visits is calculated. By fitting a regression equation to the data, a visitation rate as a function of travel costs is determined. Sometimes an entrance fee can be simulated by including it in the regression equation. The process can be repeated for successively higher simulated charges until no visits are made and an optimal charge can then be considered.

Hedonic Price Technique

The hedonic price technique (or property value method) is yet another surrogate market approach, that attempts to assess the value attributed by buyers to the environmental attributes of a dwelling. It is generally accepted that, all other things being equal, a house located in a poor environment (broadly considered) will sell for a lower price than a similar house in a better environment. Thus, the difference in house prices can be used as an estimate of buyers' willingness to pay for a better environment. The differential paid for the superior environment is known as the "hedonic price."

The proposition is simple, but complex in application. Houses are rarely of the same age, size, suitability, character, structure, number of rooms, quality, materials and presentation. These factors vary. What is true, are that houses with similar costs of construction command different selling prices, depending on their location. If the basic quality and character of a house with a similar cost of construction can be held constant, then the difference in market price, if significant, must be because of the quality of the environment.

Determining the size of the differential in the prices for similar houses is challenging, yet it reveals what financial value buyers are willing to place on environmental quality (and perhaps particular elements in environmental quality). Research in this difficult area might be simplified by talking with real estate agents. Direct contact with the market enables them to form sound opinions about the effects of different environments on property prices. Thus, a hypothetical house can be placed in a variety of hypothetical locations with an experienced real estate agent (or a valuer) offering a very good guide on the market value.

Contingent Valuation

The contingent valuation (CV) technique is one of several methods economists have developed to estimate the monetary values of the environment. It employs surveys to create a hypothetical market for the benefits people derive from the environment. The technique establishes a hypothetical market by directly asking individuals in a questionnaire, for their valuation of particular changes in the quality and quantity of an amenity. The respondents are presented with an opportunity to express their willingness to pay, or willingness to accept compensation for a change in the level of environmental amenity benefits. Use of CV relies on the assumption that individual responses to hypothetical markets reflect what their values would be if an actual market existed. The technique is so named because the values it estimates are contingent upon the hypothetical situation described to the respondent. The technique was first used in 1963.

Contingent Valuation Forms

The CV method takes several forms: bidding games, convergent direct questioning, trade-off games, moneyless choice methods, priority evaluation methods. These forms are discussed in the following sections.

(a) Bidding Games

The simplest approach in bidding games is direct questioning. Individuals are asked how much they are prepared to pay (or how much extra) to enjoy a particular environmental amenity, or bring about some environmental improvement. Bidding games can be applied also to the willingness to accept compensation for a loss of an environmental amenity. Other considerations are:

- Option value, which refers to the price that people are willing to pay to maintain the possibility of using or visiting an amenity or site; and
- Existence value, being the price that people are willing to pay just to know that certain things are being preserved but which the individual might never see, such as whales, polar bears, tropical rainforest, coral reefs, or Antarctica.

(b) Convergent Direct Questioning

In convergent direct questioning, each individual is given a high value likely to exceed any reasonable willingness to pay, and a low value which almost certainly would be paid. The higher value is reduced and lower value increased until the two values converge at an equilibrium value. The answers can be analysed in various ways.

(c) Trade-Off Games

In trade-off games, each person is asked to rank various combinations of two objects, such as a sum of money and some environmental attribute (such as water of a certain quality, or the preservation of a natural area). For any pair of combinations, the person is asked to indicate either a preference of one to the other, or indifference. The marginal rate of trade-off of money for an environmental amenity is identified at the point of indifference.

(d) Moneyless Choice Method

In the moneyless choice method, instead of using money as one of the objects, only specified commodities are used in combination with environmental attributes. The trade-off is again identified at the point of indifference. The monetary valuation of an environmental attribute is then obtained by substituting the current market value for the commodities chosen.

(e) Priority Evaluation Method

In the priority evaluation method each person is given a hypothetical sum of money to spend on conventional goods and environmental attributes at assumed prices. The game might have five objects (four goods and an environmental attribute) in three different quantities (giving 15 possible choices). As the budget is limited, clear choices must be made. True preferences and marginal valuations can be derived.

Valuation Procedure

The CV method uses surveys to elicit people's valuations of increases or reductions in the provision of environmental amenities by constructing a hypothetical market. Basically, these "markets" are outlined to the respondents by a scenario describing the amenity, the actual or likely change in the provision of the amenity, the organisation providing the amenity, and the method of payment (of park entrance fees, special funds, taxes, subsidies, etc.). Respondents are then asked for their valuation, contingent on the scenario described to them. The aim is to reveal the price at which a respondent is no longer willing to purchase the environmental amenity, thereby revealing the individuals' maximum willingness to pay. CV can also be applied to reveal a potential loss by asking people what they are willing to accept by way of compensation for environmental degradation or loss of an environmental amenity.

The CV questionnaires generally consist of four parts:

- A comprehensive description of the amenity being valued, and the hypothetical market under which the amenity is made available to the respondent. This scenario includes the payment vehicle, the institutional context within which the amenity would be provided, the initial level of amenity provision and changes in this level and the availability of a substitute;
- A series of questions designed to elicit the values attracted to the respondent's preference for different levels of the provision of an environmental amenity;
- Questions about the respondent's opinions, preferences, attitudes and use of the amenity. Demographic variables such as age, income and education are also collected; and
- A series of focus statements designed to help frame the respondent's valuation decision.

CV surveys can replicate, either a private goods market or a referendum to obtain benefit estimates.

The Private Goods Market Model

The private goods market model is best suited to quasi-private goods such as access permits to national parks, fishing and hunting permits or any other amenity where a permit or access fee is feasible. The elicitation method often used is a bidding game technique designed to resemble an auction. The interviewer raises or lowers the bid until the respondent decides to make a purchase, thereby revealing their maximum willingness to pay.

One disadvantage of this bidding elicitation is that it must be administered personally using either a telephone or face-to-face interviews. There is also substantial evidence that iterative bidding encourages people to exaggerate their willingness to pay, and therefore, biases the CV results. Some CV surveys have used payment cards, allowing the respondents to select their own starting bid. Alternatively in an open-ended question, the opening bid or the final valuation can be stated by the respondent without any prompting. In a closed-ended format, respondents are asked to answer yes or no to a proposed payment.

One of the main problems with the private goods market model is that a few extreme responses can have a major impact on the mean value. Therefore, the median value is used to obtain an aggregate.

The Referendum Model

In the referendum model, the respondents are asked whether they would be willing to pay a specific dollar amount in order to preserve the environmental amenity in question. It is a discrete choice as they can only answer "yes" or "no." A range of dollar amounts is put to a number of sub samples. The median value is often used.

Referendum models are used for public environmental amenities. Public amenities cover the non-use class of benefits (existence value, bequest value, and option value) and some use benefits such as aesthetic value which are not depleted as a result of consumption by others. Because non-contributors cannot be excluded from enjoying these benefits, they tend to be provided by the government rather than by a private market. Other considerations are:

- In a referendum model, the respondents are not required to work out precisely their maximum willingness to pay;
- The approach enhances familiarity by presenting the respondent with more market like decision setting (that is, the price is stated and the decision is made whether to buy or not at that price);
- The opportunity for the interviewer or the respondents to bias the results is minimised; and
- Discrete choice questions are more suited to administration by mail survey than iterative questions.

One of the drawbacks of this model is that it provides only a discrete indicator of the dollar amount that lies within the maximum willingness to pay instead of the actual maximum willingness to pay the amount. To overcome this problem, a larger sample size and more sophisticated statistical analysis are required, including the establishment of an upper and lower bound. This increases the amount of information obtained while maintaining all the advantages of the referendum model.

Survey Design Issues

As validity is the most important quality of measurement, CV results should represent accurately what they are supposed to measure. The factors that influence the validity of CV are:

- The relationship between attitude and behaviour;
- The provision of information to respondents;
- The disparity between willingness to pay and willingness to accept benefit measures;
- Sources of bias;
- Population specification; and
- Survey administration.

The relationship between attitude and behaviour

One important test of the validity of CV is whether the amount respondents say they are willing to pay would actually be paid if the market for that amenity is created. Bishop and Heberlein (1979) note that CV offers of willingness-to-pay are in psychological terms, “attitudes”, while actually buying and selling things is “behaviour.” A key question is whether attitudes correspond to actual behaviour. Attitudes do not always predict behaviour.

Important practical suggestions for improving the attitude behaviour link in CV studies are:

- To incorporate questions about attitudes and actual behaviour in CV applications to test the association between intentions and behaviour; and
- To design CV surveys in such a way that the respondents are encouraged to offer honest answers to the valuation question.

Some criteria for promoting a strong attitude - behaviour relationships in CV scenarios that promote the following three features are:

- Correspondence - CV surveys should aim to enhance the resemblance between the hypothetical situation described to the respondent and the actual situation in which an exchange of money could be observed. To ensure proper correspondence, CV scenarios must be designed in a way that avoids technical jargon and defines the proposed change in a way that is both relevant to the valuation problem, and plausible and understandable to the respondent;
- Proximity - more accurate predictions of behaviour are likely when the time lag is shorter between the behavioural intention measure and actual behaviour. CV studies should therefore aim to be specific about the timing of the hypothetical payments and avoid excessively long time horizons as part of the scenario description; and
- Familiarity - while respondents may be unfamiliar with evaluating the amenity, an intelligible and informative scenario can enhance the respondent’s confidence in providing a valuation.

Most CV surveys satisfy the correspondence and proximity criteria for enhancing a strong attitude-behaviour relationship. As a general rule, CV surveys should aim to be unambiguous about the nature of the amenity to be valued and the payment vehicle. The actual payment is dependent on the individual's ability to pay. Respondents may require explicit instructions to think about their ability to pay and alternative uses they might have for their money. Pre-testing of the questionnaire will help identify some of these problems.

Provision of information

People's valuation of environmental change is influenced by a range of information available to them, the way they understand the information, and how this understanding affects their attitudes and behaviour. Information about the amenity as well as information to make valuation is important.

It is a challenge to present the optimal amount of information in a way that retains the respondents’ interest and motivation, and also prompts respondents for the full range of benefits they need to account for in making their willingness to pay offer. Photographs, artists impressions and visual aids are often useful in order evoke a clear mental picture of the anticipated change. Thus, a major task of any CV study is to create, if artificially, the experience required in order to understand changes to the amenity in question. It is also important that the credibility of the institution providing the amenity is emphasised.

Willingness to Pay and Willingness to Accept

Economic theory predicts that a person's (maximum) willingness to pay in order to obtain a good should not be significantly different to the (minimum) compensation the person demands to give it up (Wilks, 1990). However, the results of CV surveys have revealed larger differences in people's responses to questions of willingness to pay and willingness to accept than are anticipated by conventional economic theory. Possible explanations are:

- Problems in the survey design, i.e., hypothetical nature of CV surveys;
- Willingness to pay measures will be constrained by the individual's budget, while willingness to accept has no budget constraint; and
- Compensation decision is less familiar to respondents than decisions involving giving up money to purchase a good "loss aversion" is an explanation offered by psychologists for the difference between willingness to pay and willingness to accept. People tend to avoid losses because they value a loss more than a gain. For some environmental issues, people may find it difficult to accept the notion compensation for benefits they never contemplated giving up.

Sources of Bias

The major forms of biases associated with CV estimates are compliance, strategic, payment vehicle, and hypothetical bias.

Compliance bias

Compliance bias is caused by respondents who alter their answers in an attempt to please the interviewers or the sponsor of the study.

Strategic bias

Strategic bias arises if the respondents believe that by providing false answers their responses will influence, and can therefore be used to further their own ends. This sort of behaviour is known as "free-riding." Free-riding occurs when an individual receives benefits from resources without paying the full values of those benefits in the expectation that the bids of others will be enough to provide the resources which are likely to understate their willingness to pay. Respondents may also overbid if they think they will not have to pay, and the amount they offer can influence the provision of the environmental amenity.

In a referendum format the simple yes - no response can help to eliminate strategic bias.

Payment vehicle bias

Payment vehicle bias occurs when the answers vary with the mode of payment.

Hypothetical bias

Hypothetical bias relates to the difficulty of obtaining consistent and accurate responses to hypothetical questions. The main problem with the hypothetical nature of CV surveys is that respondents may not take the questions seriously leading to unreliable results. Pre-testing the instrument can help to identify a scenario that respondents find unbelievable or confusing.

Population specification

Anyone who is likely to be affected by the changes in the level of provision of the environmental amenity should be part of the survey population. For issues of national significance, a national sample should be selected. Another consideration is whether the valuation data should be collected for households or from individuals.

Survey administration

CV surveys can be administered by personal interview, over the telephone, or by mail. There is no method of survey administration that is always preferred. While personal interviews have been favoured as providing more accurate data, they are usually very costly and time consuming. Mail surveys have an advantage of avoiding the possibility of any interviewer bias. However, an advantage of personal and telephone interviews is that the interviewer can carefully probe the respondent or repeat questions to clarify any ambiguous responses or misunderstanding by respondents.

Although telephone and mail surveys are generally less costly than personal interviews, these methods are limited in their ability to ensure that the respondents have a clear mental picture of the amenity in question. Telephone surveys are at a particular disadvantage as no visual aids can be used. Because of their impersonal nature, mail and telephone surveys are less likely to motivate the respondents to cooperate fully with a complex or lengthy questionnaire. In order to respond to mail surveys the respondents must be fully literate. Mail surveys are particularly vulnerable to sample selection bias because of the potential for non-respondents to be consciously self-selected. Those who have no interest in the environmental amenity in question typically fail to return the questionnaire.

Advantages of Contingent Valuation

- Flexible;
- Theoretically simple;
- Easy to apply;
- The method has an unique ability to estimate a range of non-use benefits, such as existence, option and bequest value including environmental amenities, which are yet to be supplied;
- Can also avoid the modelling and econometric problems associated with other techniques;
- CV surveys reveal an individual's intensity of preference and specific behavioural intentions with respect to the provision of environmental amenities;
- Compared with related market techniques, one of the main advantages of CV is that it permits estimation for both use and non-use benefits including those benefits not yet provided. When applied to quasi-private goods (goods that can potentially be sold to the respondents such as access to national parks, or recreational fisheries), CV appears to be as accurate as the related market techniques; and
- It also avoids the need to make the large number of assumptions required by the related market techniques.

Disadvantages of Contingent Valuation

- It provides hypothetical answers to hypothetical questions;
- Suffers from all the survey design issues discussed earlier;
- CV is also susceptible to all the standard problems associated with sampling, survey administration and data analysis; and
- CV is not applicable to those complex environmental valuation problems for which it is impossible to define vigorously the amenity to be valued and the payment vehicle.

Although the CV method appears to be biased even under the best circumstances, the degree of bias does not appear to be sufficiently high to rule out use of the results in public decision making. The case for CV application is enhanced where it is possible to obtain a clear definition and understanding of the following three factors:

- The amenity being valued;
- The theoretical and technical context of the valuation problem; and
- The policy relevance of the information sought and obtained.

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ANNEXURE 1: FUNDAMENTAL CONCEPTS AND THEORETICAL CONSIDERATIONS OF COST BENEFIT ANALYSIS

The purpose of this Annexure is to provide the conceptual and theoretical background to the work covered in the previous chapters. This material is intended for those interested in the subject matter detail of the economics of project analysis.

A1.1 DEFINING ECONOMIC EFFICIENCY

Summary*: To an economist, the objective of economic activity is to maximise the value of society's consumption over time. "Economic efficiency" is attained when the economy is functioning in a way that maximises that value. In the neoclassical economic model, "value" is measured by society's "willingness to pay" for the goods and services that are consumed as outputs or used as inputs, or both.*

Project economic analysis and policy dialogues between the World Bank and its member governments have tended to focus on the promotion of economic efficiency. The "shadow prices" (also called "accounting prices") used in project economic analysis are designed to move the economy closer to meeting the conditions necessary to achieve improved efficiency. Economic efficiency has three elements: static, dynamic, and distributional. Project social analysis focuses on all three elements of efficiency, while project economic analysis tends to focus largely on static and dynamic efficiency.

Economists normally work from the presumption that the objective of economic activity is consumption. In economics, the concept of efficiency relates to conditions under which the value of a society's consumption will be maximised over time. Current day texts on neoclassical economics tend to define three kinds of economic efficiency. These texts are discussed below and follow Musgrave and Musgrave (1980), Killick (1981), and Meier (1983).

Static efficiency relates to the conditions of full employment, in which the economy is not only using all of its resources, but is also using them "correctly" by producing the "right" combinations of output, and using the "right" combinations of inputs. The "right" combinations in all cases is defined in terms of what the market is willing to pay for a marginal unit of each output and each input – ie. the marginal demand prices. This will be true for inputs (ie producer goods) as well as for outputs (ie consumer goods).

The demand for inputs is derived from the demand for the products the inputs can be used to. Thus, input prices and the optimal combinations of inputs are also determined by consumers' willingness to pay. There is, obviously, a strong "consumer sovereignty" bias in this neoclassical approach to defining efficiency.

In the traditional economic efficiency analysis of projects, all inputs and all outputs would be valued in terms of the willingness to pay prices, rather than the prices that are actually paid. (Note that in an undistorted market, it is normally expected the prevailing market price and the willingness to pay price to be the same. "Distorted" and "undistorted" markets will be defined in later sections.)

In Gittinger (1982), for example, it is suggested that non-traded project outputs be shadow priced in terms of marginal willingness to pay. (If you are using border prices in the willingness to pay numeraire, these willingness to pay prices must then be converted to border prices using appropriate conversion factors – Gittinger (1982: 253-265); if you are using the domestic price version of the willingness to pay numeraire, then the willingness to pay prices do not need to be converted to border price equivalents.

The neoclassical economic model demonstrates that the value of present consumption to society will be maximised when the following three conditions relating to static efficiency are met:

- Making full use of the nation's resources;
- Producing the "right" combinations of outputs; and
- Using the "right" combinations of inputs.

Dynamic efficiency relates to whether the economy (specifically, consumption) is growing at the "right" rate. Again, the "right" rate is defined by the willingness of society to save and invest rather than to consume – or said in another way, it relates to society's choice of present consumption over future consumption, since future consumption is the objective of present saving and investing. In a society characterised by perfectly functioning financial markets, both the choice between present and future consumption and the opportunity cost of capital (at the margin, of course, in both cases) would be indicated by the market rate of interest.

The economics literature discusses various distortions that may dictate the use of interest rates other than the prevailing market rates (see Gittinger, 1982: 313-315); Sandmo & Dreze, 1971; and Atkinson & Stiglitz, 1980: 474-480). In any case, some discount rates is needed in project planning to compare future consumption with present consumption. This is necessary, because we must be able to tell whether the "with project" option or the "without project" option is more efficient in terms of a society's willingness to pay for the different consumption streams that result from the alternative uses of the resources that will be tied up by the project.

In the simplest applications of economic efficiency analysis, the economic opportunity cost of capital is traditionally used as the discount rate in choosing from among the project alternatives. Gittinger (1982: 313-315) briefly discussed different approaches to choosing the discount rate, but does not suggest that any of the alternatives be selected in isolation. In general, the agricultural project planner should use the rate that is suggested by the Planning Office. This suggestion has a rational basis, since both static and dynamic efficiency require that all agencies use the same discount rate in appraising their projects.

Static and dynamic efficiency is generally treated together by economists. The reasons become obvious once we give a little thought to the three aspects of static efficiency mentioned earlier. First, the issue of the "right" combination of outputs immediately raises questions about producing consumer goods versus investment goods. The question about what the right combination of these outputs is cannot be answered until we have a mechanism for valuing future consumption (the object of the investment goods) against present consumption (the object of the consumer goods). Second, the issue of the right combination immediately raises the question of the economic cost of producer durable inputs like machinery versus the economic cost of nondurable inputs like labour.

Much of the "policy dialogue" between international development agencies and governments of developing countries take place over the issue of static and dynamic efficiency. For example, fertiliser subsidies are sometimes challenged because they tend to distort the relative prices of inputs and to lead to the "wrong" combinations of inputs being used. Similarly, administered prices for food grains tend to distort the relative prices of outputs and to lead to the "wrong" combinations of outputs being produced. For instance, a subsidised price for what may lead to overproduction of wheat and underproduction of rice, relative to consumers' willingness to pay for the two commodities; at the same time, the wheat subsidy may lead to production of wheat on land that is far better suited to production of rice or other food crops.

By the same token, subsidised interest rates often have a detrimental effect on both static efficiency and on dynamic efficiency. In static efficiency terms, subsidised interest rates may lead to the use of the wrong combination of inputs – specifically, the use of too much capital (eg machinery) and too little labour. In dynamic efficiency terms, subsidised interest rates may disturb financial markets to the point of actually reducing incentives to save and distorting the choices between present and future consumption.

Distributional efficiency relates to whether a society feels that its total output (consumption) is optimally distributed. There is no willingness to pay prices to serve as references in determining whether this aspect of efficiency is being met. Thus, distributional efficiency is vulnerable to criticism on grounds of being subjective.

The social analysis introduced by the OECD (1969) and by UNIDO (1972) sought to incorporate considerations of distributional efficiency into the cost-benefit analysis of projects. These two works did not totally invent the concern with equity, of course: government officials, as well as many economists, had been concerned with these questions long before the OECD Manual was published. We should note, however, that distributional efficiency did not have a prominent place in the texts used in teaching "principles of economics" before the 1970's. See Lal (1974) for a comparison of the OECD and UNIDO methodologies.

The neoclassical approach to economic policy has tended to focus on static and dynamic efficiency and to leave distributional efficiency issues to politics and philosophy. In fact, a group of economists who view themselves as "positive scientists" – generally labelled the "positivists", and led by Nobel laureate Milton Friedman (1966) – argue that economists can tell politicians about the distributional implications of economic policies; but, the positivists argue, positive science should not tell politicians what the proper income distribution should be, nor should they say what the value of a rupee of income be to one individual compared to another. The addition of income distribution objectives to cost-benefit analysis, the, appears to the positivists to be a journey into normative judgements – a venture which many positive scientists would not be willing to undertake.

Cost-benefit analysis has only one objective – economic efficiency – and uses a form of economic efficiency numeraire to focus on static efficiency and dynamic efficiency. It ignores distributional efficiency. In other words, economic efficiency analysis assumes that each rupee of income is equally important to each individual in society. In this analysis, each rupee of income receives an income weight of 1 – regardless of who receives it.

Distributional efficiency is not taken into account until we get to the third step in the Squire-van der Tak method – the social analysis. Squire & van der Tak (1975) divide the project appraisal process into three sequential steps: financial analysis, economic efficiency analysis, and social analysis. Gittinger (1982) does not discuss the details of this third step, and so we shall not pursue it further in this volume. (For an idea of how economic prices might be used to reflect the distributional concerns in project analysis, see Case 14 in Part V, which discusses the economic values of white and yellow maize in The Philippines.)

A1.2. MARKET FAILURE AND THE ROLE OF GOVERNMENT

Summary*: Under certain conditions, free markets will automatically achieve economic efficiency. However, there are many cases in which markets depart from these conditions. Neoclassical economics defines those departures as "market failures".*

In the face of market failure, neoclassical theory prescribes "optimal interventions" to restore the requisite conditions (or to substitute for those conditions) so that efficiency will be restored. In the neoclassical model, the government's role is to undertake these optimal interventions. In real life, however, government intervention is often non-optimal – that is, it does not optimally correct for market failures. In addition, governments often intervene in cases in which the market has not failed on its own; and the intervention itself disrupts efficiency.

In this annexure, non-optimal interventions and unwarranted interventions are grouped together under "government failure". If all interventions were warranted and optimal, the resulting financial prices would approximate economic values, and shadow pricing would not be required in projects involving marketable goods and services (such as most agricultural and industrial projects). When government failure exists, some form of shadow pricing may be required in planning and appraising projects.

In neoclassical economic theory, freely functioning markets will automatically lead to static and dynamic efficiency, so long as certain conditions are met (Killick (1981). These conditions are generally referred to as the conditions of "perfect competition".

Perfect competition basically means that:

(a) Each market is characterised by a large number of buyers and a large number of sellers of undifferentiated products. (Current day market analysts would term these products "commodities".)

(b) Each product has the attributes of a private good:

- The owner can exclude others from using it.
- Title to the good or service can be bought and sold in a market.
- Producing and using the good affects nobody other than the buyer and the seller.

(c) All market transactions are entered into freely (ie without coercion or interference by outside parties) by both buyer and seller.

Neoclassical economics recognises that "market failures" may prevent static and dynamic efficiency from being achieved. Market failures relate to situations in which markets for particular goods and services fail to meet the conditions of perfect competition mentioned earlier.

In the case of market failure, the government should intervene in the economy in a manner that will correct for those failures and which will lead to static and dynamic efficiency being achieved. In other words, the government's role in the economy (via projects, programs and policies) should be to produce "optimal interventions" to correct for market failures. (A distinction will be made later between market failure and government failure.)

When markets fail, the prices that are paid in those markets may lead to consumption and production decisions which do not contribute to national economic efficiency (ie static and dynamic efficiency).

Shadow prices are used in project economic analysis to partially correct for the misallocations that occur in the economy because of distorted prices resulting from market failures.

Government interventions may be viewed as "optimal" when they help restore the conditions needed to achieve economic efficiency. Interventions which disrupt economic efficiency, or which do not fully restore the conditions for economic efficiency, may be viewed as "non-optimal interventions". Unfortunately, in many countries, government actions – rather than correcting for the distortions caused by market failures – often worsen the distortions. Frequently, governments add new distortions by initiating policies, such as protective tariffs, import bans, and export subsidies; and by taking various measures to change prices in markets which – in many cases – would otherwise meet the requisite conditions to be considered competitive markets. In particular, they include restrictions on international trade in products in which border prices represent an effective, inexpensive, and equitable mechanism for regulating producers and consumers in the public interest.

Examples of market failure fall under four broad headings:

(a) Monopolistic elements (which include natural monopolies such as public utilities and imperfect competition);
(b) External economies;
(c) Public and quasi-public goods; and
(d) The paradox of thrift and fallacies of composition.

These items are discussed in the later sections.

Government failure can be divided into two categories:

(a) Interventions designed to correct for market failures but which, in practice, turn out to be inappropriate, insufficient, or excessive; or
(b) Interventions which disrupt otherwise efficiently functioning markets.

The accounting prices that are used in project economic analysis are designed to partially correct for the distortions caused by market and government failure. In other words, these prices allow us to recommend projects that improve the degree of static and dynamic efficiency.

In agricultural projects, the shadow pricing often tends to focus on correcting distortions caused by government policies. One important reason for this is that the agricultural sector in most countries comes closest to meeting the economists' model of perfect competition – ie. large numbers of buyers and sellers, producing undifferentiated products, and so forth. In many developing countries we find that, in practice, corrections for policy-introduced distortions tend to be one of the more important corrections involved in the shadow pricing exercise.

Shadow pricing *may be viewed as a correction for government failure of either the first or the second type defined earlier. The need to use accounting prices may be looked upon as a criticism of the government for failing to optimally intervene in the economy. In some sense this is true, since accounting prices would not be needed if governments could find a way to restore in every market the requisite conditions for economic efficiency.*

However, we must also recognise that economic efficiency is not the only objective of society; and it is not the only objective of the government. Thus, we should not seek to make it the only factor to consider in project and policy analysis; and the economic efficiency accounting prices that we shall discuss shortly cannot be the only "values" that count. However, we should also keep in mind that the economic conditions faced by most countries in the latter half of the 1980's make it more important than in the past two decades that economic efficiency issues be given prominence in the economic planning and management processes of all countries.

To plan with economic efficiency in mind requires that we understand the circumstances under which economic efficiency is achieved, the circumstances which disrupt economic efficiency, and how to judge interventions in the agricultural sector in terms of whether or not they help us restore the requisite conditions for national economic efficiency.

A1.2.1 THE THEORY OF MARKET FAILURE

In project economic analysis, we talk about economic values based on society's willingness to pay for the inputs and for the outputs that are involved in a project. We have already said that taxes, for example, do not normally represent real resource flows in the financial accounts. So, one of the first things to do is conducting economic analysis is to delete the taxes from the accounts, since they do not represent real resource flows. Similarly, subsidies (eg export subsidies) also do not represent real resource flows; therefore, they should also be ignored. Such taxes and subsidies constitute "transfer payments", not real flows of resources.

But, what about the other "money flows"? Do they constitute real resource flows? After all, they (unlike the taxes and subsidies) are payments made on a per unit basis for real inputs and for real output. Don't they measure for us the willingness to pay, since they obviously represent payments that people make for actual goods and services?

The answer is that financial payments other than the taxes and the subsidies may or may not accurately represent the real willingness to pay for the project's inputs and outputs. The practical question is whether the prices that are actually paid accurately measure the willingness to pay. Let us discuss this issue further. First we will talk in theoretical terms. Then we will get down to specifics.

Economic values reflect the values that society would be *willing* to pay for a good or a service. Financial values, in contrast, are the prices that people *actually* pay. In project economic analysis, the task, of course, is to convert the financial prices into economic values, or to "adjust" the financial prices so that they more accurately represent economic values. So an understanding of the difference between what is actually paid and the willingness to pay values is very important.

Economic values may differ from financial values for a variety of reasons:

(a) Market failure;
(b) Government failure; and
(c) Merit goods and demerit goods.

In the presence of these factors, the prices actually paid may differ from what people would be willing to pay for those same items. For example, because of subsidies, consumers may pay less than they would be willing to pay. If we took the financial price as the indication of the real value of that item, we would end up undervaluing that item.

Market failure occurs because of the specific characteristics of a particular good or service, or because of the production technology for that good or service. Public utilities which are "natural monopolies", represent examples of market failure. Another example is industries that pollute air or water and, thus, impose uncompensated costs on other people.

In principle, the government needs to intervene to restore "socially optimal" production, consumption, and pricing (where pricing is possible) of the good or service affected by market failure (Musgrave & Musgrave, 1988). For example, natural monopolies – such as telecommunications, electricity, and water distribution – normally are regulated or owned by the government. The objective is to ensure that these companies behave in socially beneficial ways (Saunders, Warford, & Wellenius, 1983).

Government failure, in contrast, results from "non-optimal" intervention by the government. It constitutes interventions that do not correct for market failure, or interventions that actually make society worse off.

Merit goods represent goods or services considered necessary for a "decent" standard of living. (Demerit goods – eg tobacco and alcohol – are viewed as having a negative social merit). Merit goods represent an apparent departure from the willingness to pay measure of value. The willingness to pay is usually based on an amalgamation of individual values that are expressed in consumer demand. The concept of a merit good is based on the idea that there are values that are held in common by society – values that are different from those expressed in individual demands (Musgrave & Musgrave, 1988).

Examples of merit goods include public housing, support for the arts, and minimal subsistence. They may also include access to educational opportunities and adequate health care. In many cases, these values come to be accepted as basic human rights. Governments generally assume responsibility for providing these goods and services. Attempts to subsidise the availability of food grains, for example, are often justified as attempts to provide a merit good. We will see later that merit goods are particularly difficult to deal with in the project economic analysis.

A1.2.2 MONOPOLY ELEMENTS

Natural monopolies occur when major economies of scale exist for a non-tradable good or service. *Economies of scale* means that the average cost of supply decreases over a wide range of production scales. Economies of scale tend to be important in the provision of services that have large and costly distribution systems, such as power grids, natural gas pipelines, water distribution systems, and the like.

It is "natural" to monopolise the provision of these services, since it does not make sense to duplicate their very great costs in several firms as a way of having competition.

The cost considerations are important since natural monopolies tend to have a large element of fixed costs (eg the transmission and distribution networks for electricity, irrigation, and urban water supply). Many of the public utilities have high fixed costs – primarily because of the cost of distribution systems like pipelines and transmission lines. As a result of these fixed costs, the average cost of supply in these sectors tends to decrease as output increases. This is what is meant by "economies of scale". Because of this tendency for average cost to decrease as scale increases, there will tend to be only one firm in the sector – hence, the sector will be "monopolistic' by nature.

A free market would fail to provide an economically efficient outcome in the case of natural monopolies, because there would be no competition – neither local nor international – to regulate the behaviour of the monopoly in the interest of society. For a free market to work efficiently and in the interest of society, the market for that good must have certain characteristics. One of these is that there must be a large number of buyers and a large number of sellers of the product so that competition will protect society from predatory practices.

In neoclassical economics, economic activity is seen as an interplay between motivating forces and regulating forces. Neoclassicists believe that individuals' desire to improve their own and their family's welfare is the primary motivating force in any economy. This motivating force is assumed to be based on an inherent drive for personal gain. Because the "natural" drive to improve their own welfare may lead individuals to behave in ways that are costly to others, society will need some regulating force to prevent individuals from taking advantage of other people.

The neoclassical theory presents convincing evidence that competition, where it can be achieved, is a very effective and low-cost regulator; and where competition exists on both sides of the market for a pure private good – ie. "perfect competition" – the interplay between the motivating force of individual drive and the regulating force of competition will help maximise society's welfare.

Of course, this natural interplay between motivation and regulation occurs only in cases of perfect competition. In other cases, some other form of regulation may be needed. In the case of natural monopolies, for example, the regulatory force of competition will not be present. Often, the government will step in to play the role of a regulator. In those cases, government regulation, in principle, should attempt to do the same things that real competition would do – were it possible to have positive competition.

These regulatory objectives are meant to lead the supplier to:

(a) Build the most efficient scale of plant;
(b) Operate the plant at its lowest cost level of output;
(c) Price the service to meet the objectives of:

- Economic efficiency;
- Financial mobilisation; and
- Equity; and

(d) Be responsive to the needs of its customers.

In the best interests of society, the government should intervene to regulate the natural monopoly "optimally". The economics literature contains hundreds of volumes dedicated to helping public utility managers operate these firms in a socially optimal fashion (eg Munasinghe & Warford, 1982; and Saunders, Warford &Wellenius, 1984). For a variety of reasons, it is a difficult task to accomplish.

However, if the public monopoly is regulated optimally, then the financial price of, say, electric power would represent the economic value of that electricity. No accounting price would be needed in appraising projects which use electric power as input. Government intervention would have corrected for the market failure and the monopolistic power company would have been behaving in the same way that it would under perfect competition.

Unfortunately, we will find that natural monopolies are not regulated optimally. Generally, electric power is provided to consumers at a price below its replacement cost and below the price that the user would be willing to pay for that amount of electricity. In Egypt, for example, consumers pay a price that is approximately one-third of the cost of supplying electricity. In a project which used this electric power as an input, we would have to shadow price the electric power – ie. use an economic value which was different from the financial value.

Imperfect Competition. Monopoly elements may exist in other ways than through natural monopolies (or public utilities). Various forms of imperfect competition may exist for a wide range of products. Imperfect competition tends to be more common in manufacturing and in marketing services than, for example, in agricultural activities. Nonetheless, we may still find imperfect competition existing at the local level in the supply of inputs or services to farmers, or in the collection and marketing of agricultural outputs. For example, a developing country may have only six domestic foundries that produce pumps for irrigation. If those six firms collude, either explicitly or tacitly to fix the price of pumps, social welfare may be affected. So we may have to shadow price the cost of pumps in making an economic analysis of the agricultural project. And if we need to shadow price the outputs of a sector, then we may also wish to recommend that a sector or policy analysis be conducted for that sector.

The need to shadow price the pumps may lead us (or the project planner in the country concerned) to recommend policies for dealing with monopolistic elements in the foundry sector. We would not overlook these "policy implication" aspects of the project analysis. No one will be in a better position than the project analyst to identify the positive and negative effects that government policies have on the sub sector, because no one else in the government is likely to have the detailed micro-level understanding of that sub sector. In all cases involving the use of shadow pricing, a more desirable alternative would be to design an optimal intervention to correct for the underlying market failure that leads us to use an accounting price.

Any form of imperfect competition may force financial prices to diverge from economic values and may make it necessary for us to estimate accounting prices in conducting project economic analysis. Also when competition is so imperfect as to complicate the estimation of the economic values, we should begin to think beyond project analysis and start looking into the need for policy reforms as well. Economics includes more than the theory of shadow pricing: there are specialised areas which deal with the theory of regulation in each of the areas of market failure discussed in this annexure. Shadow pricing and project planning should not be carried out in isolation from work being done in the country based on knowledge from these other areas of economic analysis.

A1.2.2.1 A REVIEW OF NATURAL MONOPOLIES

Let us quickly review our discussion of natural monopolies.

- We have said that economic values will sometimes differ from financial values. This might occur because of the second type of government failure: the failure to intervene optimally to correct for the natural monopoly type of market failure.
- In the case of a natural monopoly, the government should design optimal interventions – including optimal prices.
- Sometimes the government will no regulate prices to optimal levels in thee natural monopolies; therefore, "accounting prices" will have to be used in the economic analysis. In this case, the economic values would be different from the values that were used in the financial analysis.

A1.2.3 EXTERNAL ECONOMIES

A second group of market failures involves "external economies". (A very useful reference for this section is Cornes & Sandler, 1986). An *external economy* occurs when an economic activity affects a "third party" – someone other than the producer and the buyer. The result of an external economy is that some production or consumption impacts will not be "internalised" in the financial price that is paid for the good. By "internalised" we mean that some costs or benefits are not included in the financial statements of the supplier or of the buyer. Rather, it occurs "external" to these statements and affects a third party.

Technological Externality. A "third party" impact, or an external economy, might occur in a feedlot operation, for example. The third party might be downstream users of the water from a small stream that was polluted by waste run off from the animal stalls. In this example, the financial cost of producing meat would not reflect the true cost of society – unless, of course, the government were to intervene to impose a "socially optimal pollution tax" on the meat producer. (To be "optimal", the tax should be equivalent to the net real costs borne downstream and not otherwise reflected in the price of the meat.) Economists call the type of external economy dealt with in this example a "technological externality".

In most countries, "socially optimal pollution taxes" do not exist, though environmental economists have argued for such policies for many years. Thus, in principle, the shadow pricing for the project economic analysis should try to reflect the downstream externalities as well as the "internalised" costs borne by the producer. The economic cost of the meat produced in the feedlot would include not only the cost of the animal feed (which would already be internalised in the financial value), but also the costs borne by the downstream users of the water (which would not be "internalised" in the financial value). Thus, the economic cost of the meat would be higher than its reported financial costs. The "internal economies" (ie those values that accrue to the buyer or seller) will be reflected in the financial values, so they will be relatively easy o determine. However, it will usually be difficult to estimate the full cost, or full value, of external economies.

Linkage Economies. Some economists include "inter-sectoral dependencies", or "linkage economies", under the heading of external economies and suggest that these linkage economies represent justification for government activity. Examples of linkage economies are often found in the natural resource development sector – particularly in mining and large-scale timber operations. Linkage economies also form an important reason for the attempts at integrated planning, such as the regional planning system implemented in the Philippines over the past decade.

As an example of linkage economies, let us discuss a proposal to develop a large-scale ore mine in an undeveloped area of a developing country. The export of the ore might require investment in three separate sectors:

(a) In the ore mine itself;
(b) In a rail link to tie the mine to the nation's rail network; and
(c) in a port expansion to handle the additional load on the port.

Expansions in these three linked sectors – mining, railways, and the port – should, ideally, be planned together. Many economists argue that such integrated planning is best undertaken by the government. But, in addition to the problem of integrating the planning, each link in the ore exporting system might represent a monopolist vis-à-vis the other link. In addition, the system might have difficulty functioning if there were three or even two separate private firms involved.

Some governments have therefore decided that such interlinked operations should be owned or controlled by the state. A moment's thought will show why this conclusion has been reached. A private mine facing a private railroad would involve a monopolist facing a monopsonist. The outcome would likely be determined by the one with the most financial, political, or – perhaps – private military power. Ultimately, the more powerful firm would likely end up buying the assets of the weak at less than their original cost and the battle in between might be costly to society.

Thus, where such inter-sectoral dependencies exist, governments often step in to undertake the development of the linked sectors, or at least to participate in the planning and in controlling their development. The government might choose to own part of the interlinked system – eg the rail link and the port. Similarly, in irrigation supply, governments often choose to be the monopolistic provider of water in that closely interlinked production system.

Information Economies. Sometimes, information economies are included under the heading of external economies. Information often readily becomes part of the public domain. Not only is it difficult to control information for private use (eg research findings), it may also be undesirable to do so. This is particularly true in the case of information which might affect the health of welfare of a large part of society.

The government often engages in activities designed to generate and to distribute information. Agricultural research and extension are examples of such activities. Similarly, the government often assists in providing market information to agriculturists and others by sponsoring radio programs which provide timely information to producers.

It is difficult to put a willingness to pay value on any of the forms of external economy that we have discussed – in particular linkage economies and information economies. In this respect, they are similar to the public and quasi-public goods that we shall discuss shortly. Yet, like these goods, we will sometimes have to deal with them in agricultural and, in particular, rural development activities. In a later section, we will discuss various means for dealing with items, such as these, that are difficult to value in willingness to pay terms.

Pecuniary Externalities. Production and purchase decisions often have third-party effects which occur through the prices paid or received by others. For example, the decision by a wealthy eccentric to buy and hoard canned goods may cause the price of canned goods to rise in the short run. The increase in price may have negative impacts on other consumers. Likewise, a government's decision to build a hydroelectric dam may cause the price of cement to rise. This effect on the price of these goods may be viewed as a "third-party impact", just as are the technological externalities discussed previously. These impacts on the price are termed "pecuniary externalities".

Pecuniary externalities obviously can have an impact on the distribution of purchasing power in society; they are normally ignored in economic efficiency analysis, because the increase in price that harms one party usually benefits another. If both the payer and the payee of the higher price are citizens of the country, then the pecuniary impacts may be viewed as netting out to zero. However, if the pecuniary externalities relate to a good that the country imports or exports, then it should be taken into account as an aspect of market failure for which government intervention would be appropriate.

If the country is a major exporter of an item (eg Bangladesh jute, Brazil coffee, Malaysia tin and rubber, Egypt long-staple cotton, Ghana cocoa, and Thailand rice), then the optimal policy for that sector may be to impose an export tax to force exporters to internalise the pecuniary impact their incremental exports will have on other producers.

Increasing and Decreasing Returns to Scale. Scale economies are sometimes discussed under the heading of external economies. The presence of increasing returns to scale and competitive input markets is likely to lead to monopoly. This problem has been discussed in the preceding section of natural monopoly. In principle, it is possible o treat all aspects of market failure as forms of external economies.

Public and Quasi-Public Goods. A third category of market failure involves "public goods" and "quasi-public goods" (see Cornes & Sandler, 1986). Public and quasi-public goods will not be provided in optimal quantities by private markets because of two characteristics that make them different from "private goods". See Schmid (1978 and 1987: 40-42) for an iconoclastic discussion of the conceptual problems surrounding the definition of "private" and "public" goods.

A *pure public good* has two distinctive characteristics. First, people who do not buy the good or service cannot be excluded from consuming the good or service. For example, a clean environment is available to everybody, once it is provided. So is national defence. This is called the "non-exclusion" characteristic of a public good. Second, one person's consumption of a public good does not come at the expense of another person's consumption. Up to the point of congestion, my enjoying a beautiful view does no deprive you of being able to enjoy it. This aspect is called the "non-competitiveness in consumption" characteristic of a public good.

A *quasi-public good* has some attributes of a public good, but does not have all of the required characteristics to be considered a pure public good. Examples of quasi-public goods include education, public health, police protection, and fire protection.

A *private good*, by comparison, is different from a public good in that, first, a private good can be made available to one person at a time – ie. it can be "titled". The title can be transferred and non-purchasers can be excluded from the benefits of consuming it. An automobile is an example of a private good. So is a bottle of soft drink. This is called the "exclusion principle" and must be met for a good or a service to be provided in private markets. Second, one person's use of a private good deprives some other person from using it. By consuming a soft drink, the user deprives someone else of the opportunity to do so. This is called "competitiveness in consumption". It means that each person who wants to consume the good must pay for the right to do so – there is none of the "free rider problem" associated with public and quasi-public goods.

Public and quasi-public goods usually are provided by the government and are paid for through government expenditure. This is as much for practical reasons as it is for reasons of principle. Because of the free rider problem and the nature of the demand for public goods, these goods must be provided by the public sector, and they cannot be sold like private goods. Thus, usually, there will not be a financial price paid for these goods.

The Free Rider Problem. Once public goods are provided to some individuals, others cannot be excluded from access to those goods. For example, once the air is made clean, everyone can enjoy the clean air – whether or not they paid for the cleanup. Economists refer to this as the problem of "non-excludability", and gives rise to a second problem – the free rider problem. Joint public action will be required in dealing with public goods: the free rider problem will cause everybody to sit back and wait for others to pay for the provision of public goods, resulting in their under provision.

The Nature of the Demand for Public Goods. Public goods cannot be broken into individually consumable units. For example, many of the most effective means of controlling water-borne diseases cannot be divided and sold in packages to individual consumers. This "indivisibility" problem affects our ability to derive a total demand function from the individual demand functions for public goods. For private goods, the total demand is derived by adding a number of units demanded by each consumer at each price – ie. by "horizontally adding" individual demands.

Public goods, in contrast, do not exist in units. Thus, to derive the total demand for public goods, the willingness to pay by each individual for the total availability of the good is added – by "vertically adding" the individual demands. In concept, this determination of the total demand is important, because one of the functions of economic analysis is to assist in deciding on the optimal amounts of each public good to provide.

If a project produces a quasi-public good, or uses it as an input, there will be no "reference point" for estimating the willingness to pay value, because there will be no financial price for the good. Thus, goods of this sort tend to create the greatest difficulty in conducting project economic analysis.

A1.2.4 PARADOXES AND FALLACIES

The Paradox of Thrift. The neoclassical list of market failures was augmented by John Maynard Keynes' "discovery" of the paradox of thrift. Many economists consider this to be one of Keynes' greatest contributions to economic thought (Amacher & Ulbrich, 1986: 204). The paradox of thrift is related to the fallacy of composition discussed below.

The problem, according to Keynes (1936), is that planned savings, is undertaken on a large scale by a number of individuals, may cause a reduction in aggregate demand and lead to a reduction in incomes from which actual savings will occur. The result may be that both income and actual savings will be lower than anticipated.

In the Keynesian approach to economic management, the government's function is to undertake macroeconomic interventions in the form of fiscal and monetary policies to correct for the impacts that such a paradox might have on the employment, income, and price levels in that economy.

The Fallacy of Composition. It is "a fallacy in which what is true of a part is, on that account alone, alleged to be also necessarily true of the whole" (Samuelson & Nordhaus, 1989). This fallacy is most apparent in the agricultural sector in the behaviour of commodity prices. If one farmer succeeds in increasing his output through, say, increasing his crop yields, then his revenue would be expected to increase. However, given the inelastic demand for many agricultural commodities, increased yields by all farmers might result in lower revenues for each farmer.

Many issues of trade policy revolve around understanding the implications of the fallacy of composition. For example, imposing a protective tariff may help producers of the protected product and may even improve the balance of payments (at least in the short run). However, large-scale use of tariff protection may raise the cost of exports, hurt other producers of tradable goods, and actually worsen the balance of payments situation (see Harberger, 1971).

Similarly, when a country is a major producer of an exportable commodity, individual farmers may increase their incomes by increasing production for the export market. However, large-scale increases in the production of price-inelastic commodities may make all exporters worse off.

This "augmented" neoclassical theory of market failure, then, sees two sets of roles for the government:

(a) Sector and market-level interventions designed to correct for market failures which occur market by market; and
(b) Macroeconomic interventions designed to maintain full employment, stability of price levels, and external balance (see Cornbusch & Helmers, 1988).

A REVIEW OF MARKET FAILURE

Let us summarise again. There are three categories of market failure where shadow pricing may be required:

- monopolistic elements;
- external economies; and
- public and quasi-public goods

Natural monopolies may not require shadow pricing, if government intervention is "optimal". However, experience has shown that there are few examples of such optimal intervention. Output prices may not reflect the actual willingness to pay by consumers of the natural monopoly's output; then economic values will be different from the financial values. It might sometimes be difficult to estimate the appropriate economic values for the outputs of public utilities, but it is basically a research problem and is not impossible by any means. It is time consuming, though.

Imperfect competition may require that financial prices be adjusted in determining real economic values. This too is basically a research undertaking, which usually can and should be done where the "imperfect competitor" is important as a supplier of project inputs, or as a purchaser of project outputs. ("Important" is usually defined, for practical purposes, to mean more than 10 percent of project costs or benefits.)

External economies will almost always involve costs or values which are not reflected in the financial values. It will also be difficult, in most cases, to accurately estimate the actual extent and values of these external economies. At least in the case of technological externalities, this too is a research problem; but it is usually a more difficult one than that for natural monopoly or imperfect competition valuation. For linkage economies and information economies, the valuation problem can be particularly difficult.

Public and quasi-public goods are, by their nature, generally not subject to market provision and market pricing. 'Thus, it will usually be very difficult to estimate the willingness to pay value of these types of goods. As a result, they will often be treated as "intangibles" in the cost-benefit analysis and, if economic analysis is done, the form of economic analysis used for projects producing primarily public or quasi-public goods outputs will be either "least cost" analysis or "cost effectiveness" analysis.

Paradoxes and fallacies in relating individual behaviour to aggregate economic performance lead many economists to argue that government intervention is required in managing the macro economy. The existence of unemployment resulting from macroeconomic imbalances may lead to the need for shadow pricing labour in the analysis of project and policy interventions. Disruptions in the foreign exchange market may suggest shadow prices to correct for temporary shocks that distort the exchange rate through temporary capital account flows.

A1.3. GOVERNMENT INTERVENTIONS AND THE NEED FOR SHADOW PRICING IN BENEFIT-COST ANALYSIS

***Summary**: Government interventions lead to system failure when the government intervenes in the economy in an unwarranted, inappropriate, or non-optimal manner. Government "failure" creates "distortions" in the financial prices faced by producers and consumers, which lead them to make production and consumption decisions that are not economically efficient. These distortions are broken down into two elements: "border distortions" and "domestic distortions". A distinction between these two terms would be useful in deriving and using the accounting prices for correcting price distortions; these topics are discussed in the chapters that follow.*

The introduction of the concept of "merit goods" clouds the definition of government failure and, along with the inclusion of distributional issues in project planning provides a background for the emergence of the social analysis (or the multi-objective approach). When merit goods and political and other considerations lead to large-scale intervention by the government, the economy may become "thoroughly distorted", which makes rational planning and appraisal of projects increasingly difficult. Optimal intervention should include both project and policy interventions, and development planning should focus on both of these approaches. When government failure has created a thoroughly distorted economy, policy reform will generally be more productive than will additional project investments in the distorted environment.

Government "failure" occurs when government intervention is "non-optimal" – ie. when government intervention is either inappropriate or should not have been undertaken. Government failure may occur, for example, when the government uses a "non-optimal" import tariff to protect a favoured producer at the expense of domestic consumers, or when it uses a tariff to collect revenues for running the government.

In both cases, the tariffs may be important to other objectives, but they nonetheless impose economic costs on society. Government failure may also occur when the government bans the export of a consumer item – as Pakistan did with eggs in the late 1970's – resulting in a net reduction in the welfare of society. Though some consumers might benefit in the short run, it would be at the expense of producers; and it would also be at the expense of consumers in the long run and detrimental to the country's need for foreign exchange. So, the overall result is a net loss in society's welfare. For a survey of policy-imposed distortions in product and factor markets and the effects of such distortions on efficiency of resource allocation and growth in developed, developing, and socialist countries, see Balassa (1984).

A1.3.1 DIFFERENT FORMS OF GOVERNMENT FAILURES

The presence of government failures will require that we estimate economic values; those values will usually be different from financial values. Economic distortions caused by government failure will generally fall under two headings:

(a) Border distortions; and
(b) Domestic distortions.

Border distortions include distortions such as export subsidies and import bans, which tend to sustain an overvalued exchange rate (ie keeping high the official rate at which local currency exchanges for foreign currency). Border distortions affect the relationship between "border prices" (ie cost, insurance, and freight (CIF) and free-on-board (FOB) prices) and "domestic prices". Border distortions in developing countries tend to increase domestic prices relative to border prices. This raising of domestic prices, incidentally, is the mechanism through which the government is able to maintain an overvalued exchange rate.

The economic valuation process will have to somehow adjust for this distortion between border prices and domestic prices, because the distortion will affect the relative values of traded goods versus non-traded goods. Using the "shadow exchange rate" (instead of the "official exchange rate") in the economic analysis is one way of adjusting for the distortion between traded and non-traded goods. Using a shadow exchange rate in developing countries usually places higher values on foreign exchange and, thus, on traded goods relative to non-traded goods.

By comparison, the official exchange rate would place a lower value on foreign exchange and, thus, a lower value on traded goods relative to non-traded goods. It is the distortion in the official exchange rate that is adjusted for in the economic analysis. Using conversion factors is an alternative way to deal with border distortions in the project economic analysis.

Domestic distortions affect relationships among domestic prices. For example, a minimum-wage law will tend to raise the price of labour covered by the law relative to the cost of machinery, other inputs should be defined as a merit good; and we have no ready measure of the worth of merit goods in comparison with their costs. Thus, by accepting the idea of merit goods, we create an opportunity for those in positions of political or bureaucratic power to impose their own wishes in the name of society. This provides a potential for the practice of elitism, paid for with the use of society's resources. Publicly provided housing for public officials and publicly supported municipal orchestras in the capital city can sometimes be examples of such abuse.

In the agricultural sector, merit goods arguments can be used to justify policies which create government failure rather than provide socially optimal supplies of agricultural goods. For example, some agricultural pricing policies may nominally be aimed at providing low-cost food to society. But these policies may end up actually reducing the amount of food that is produced; or the policies may cause food to be produced at higher cost than would be possible using alternative sources or alternative technologies.

Basic Needs. However, the idea of merit goods is not totally without value. Products often defined as merit goods are also often described as 'basic needs". The market demand for these basic needs generally reflects the existing income distribution, while the government may wish to meet the basic needs of each member of society, regardless of that person's ability to pay. For example, many countries subsidise the production of food grain. A disadvantage of this policy is that the subsidies sometimes cause food grains to be produced in areas which have very low productivity for food grains, but which have high productivity for other uses. The saline estuaries of Bangladesh and other countries, for example, are much better suited to producing prawns for export than they are for producing salt-tolerant varieties of rice. Much more rice can be imported by using the foreign exchange earned from prawn exports than can be produced in some of these coastal areas.

Merit Goods and Distributional Efficiency. The provision of many merit goods can be linked to concerns about the distribution or consumption in society (eg public housing and food subsidies). In cases where such a linkage exists, the provision of merit goods may represent an attempt by planners to bring considerations of distributional efficiency into the planning process.

As we noted earlier, distributional efficiency gives economists particular difficulty in applying positivistic methods of analysis. Recall that the idea of willingness to pay, which economists widely use to measure "value", basically ignores the distribution of income that underlines the demand schedules from which willingness to pay for private goods is derived. Still, whatever case may be made for merit goods, governments must be careful not to convert merit goods into more serous cases of government failure, but such care is in any case needed of government intervention.

Now let us return to our previous discussion of what we may call "truly meritorious" merit goods and look at the problems that they create for us – problems which occur even without "non-optimal" intervention. Those merit goods which are really nothing more than basic needs may involve rejecting the willingness to pay measure of value because, for these goods, the "ability to pay" issue is considered more important. While we may find reasonable examples of true merit goods – and basic needs may be a good case in point – we must nevertheless keep in mind that each merit good creates two difficulties for economic planners in developing countries.

First, merit goods in low-income countries create difficult planning choices for governments. When per capita incomes are low and government budgets are small, there will likely be a gap between human needs (in terms of which merit goods often will be defined) and the resources available to the government to meet those needs. In these cases, choices must be made among merit goods as well as between consumption and investment. Government expenditures on one class of merit goods may carry high opportunity costs in terms of other classes of merit goods and in terms of increases in future consumption for all members of society.

Second, merit goods create difficult valuation problems for the project analyst. Once we have defined something as a merit good, we have – to a greater or lesser extent – taken it out of the category of "tangible" project impact and put it into the category of "intangibles". As we shall see later, these intangibles are much less amenable to quantitative analysis than are the tangible inputs and outputs with which we are more accustomed.

A1.3.2 WHEN DO FINANCIAL VALUES REPRESENT ECONOMIC VALUES?

We have discussed market failures which lead to financial values differing from economic values. You may wonder whether there are cases in which the market for a product does not fail. In other words, if there are cases in which financial and economic values are the same (cases in which financial values represent social values).

Let us pose the same question in a different way: When can we say that what consumers actually pay is exactly equal to what they should be willing to pay? And when is that value exactly equal to the "social value" of a good? The answer is: when there is a perfectly functioning market which has none of the aspects of market failure.

Such a perfectly functioning market would need to have the following characteristics:

(a) A large number of independent buyers and a large number of independent sellers must exist, and they must not collude to take advantage of others (no monopoly elements).
(b) The good or service must be capable of being "titled" and transferred – ie. it must be possible to market it (it exclusion principle must hold).
(c) People who pay for the good must be able to present non-payers from benefiting from the good (no "free rider" problem – related to the exclusion principle).

(d) Use of the good by one person must prevent another person from using the good (competitiveness in consumption).
(e) Production and consumption of the god or service must not cause uncompensated benefits or costs to be borne by people who are not engaged in the production or consumption of the good (no externalities).
(f) Government intervention must not be economically "non-optimal" so that financial values do not differ from economic values (no government failure),
(g) The good must not have the attributes of major merit or demerit goods.

Obviously, few markets meet all of these criteria. (Perhaps no markets meet all of these requirements all of the time; see Schmid, 1978). This is true in developed countries, as well as in developing countries.

Elements of market failure are widespread. Monopoly elements are found in every country – particularly in developing countries where the size of the market for many products is small and thus very easily monopolised. The need for government intervention – through projects, programmes, and policies – to correct for these market failures is readily apparent. However, that intervention should be planned and analysed very carefully.

But, government intervention is not always carefully planned and analysed. Often, it is undertaken to meet narrow interests rather than to meet the broader social interest. Again, this is rue in both developed and developing countries. Government failure can create distortions in the economy which are more serious than those caused by market failure. In economies which have serious distortions of this type, it is very difficult to plan and implement projects.

We can make three generalisations regarding countries which have serious government-introduced price distortions:

(a) It will be difficult to plan and implement viable projects in such an environment.
(b) It will be difficult to estimate the economic values to use in project analysis in such an environment.
(c) Changing the policy environment which is responsible for the price distortions will often be more productive than implementing another project in the existing, highly distorted environment.

Project planning and analysis comprise just one part of development planning. Perhaps, more so important – is the policy environment that the government creates and is expected to maintain. Consider, for example, the case of a country where, depending upon the trade policies the government pursues, a tradable commodity may be valued as if it were intrinsically a non-traded good. The extent to which we must carry out shadow pricing – ie. substitution of economic values for financial values – when we conduct project economic analysis tells us to what extent the policies being pursued by the government are the correct ones from the standpoint of society's economic welfare.

We would not have to conduct an economic analysis separate from the financial analysis of the project (ie financial values and economic values would be the same) under the following circumstances:

(a) Market failures were corrected by economically optimal government intervention.
(b) There were no government failures, because the government did not intervene in markets which did not have some element of market failure.
(c) The government was able to raise the revenues necessary to carry out its optimal interventions without having the taxes themselves create (major) distortions.

Obviously, it would be very unusual to find that all the values in the project financial accounts could be accepted as representing real economic values. Thus, we will usually have to shadow price at least some of the values in the project financial account in conducting the project economic analysis. We will also have to use the knowledge that we achieve in the process to assess policy options that would increase the efficiency with which that sector functions. See Singh, Squire & Kirchner (1985) and their references to some techniques under development at the World Bank to assess the impacts of alternative agricultural pricing policies in the individual countries.

A1.3.3 TAXATION AND SHADOW PRICING

Up to now, we have treated the shadow pricing problem as though it would go away if governments would simply manage economies correctly. This has been the traditional approach to project economic analysis (partly by choice, and partly out of necessity). In this approach, the need for shadow prices presumably derives from the forms of government failure. This approach to economic analysis has generally been viewed as a necessary expedient – necessary, because of the lack of an implementable theory of shadow pricing based on a fully developed theory of trade and of public intervention. The need for shadow pricing generally has been accepted by practitioners, because of the widely held view that correcting for inappropriate government interventions was, in practice, the most important job to be done in project economic analysis.

At the same time this approach to shadow pricing was being practiced, work continued on broader issues related to the theories of trade and the public sector. Much of the latter work was published under the heading of the "theory of taxation". (The Newberry and Stern volume, cited in the Bibliography at the end of this volume, provides a good summary of the status of that work at this writing).

In simple terms, work on the public sector starts from the premise that it is practically impossible for a government to act to remove all distortions in the economy. Indeed, the very act of removing one distortion will create another. Thus, in practice, the problem is essentially one of determining the "best" set of distortions, since we know that there will be distortions; this is referred to as the broader economic problem of second best. In this, much more complicated environment, "second best shadow prices" represent the prices which take into account several inherent conflicts and trade-offs facing managers of the public sector.

A fundamental conflict exists in the various functions of government that are postulated in most contemporary texts on public finance, a subfield in economics that is increasingly being referred to as "economics of the public sector" (see Musgrave and Musgrave, 1988). These functions include:

(a) The allocation function (ie static and dynamic economic efficiency, the subject of this text);
(b) The stabilisation function (ie macroeconomic management); and
(c) The distribution function (ie equity, including attention to income distribution issues).

The first fundamental conflict occurs because government is given the role of providing public goods to meet the allocation function. A basic problem is that to provide public goods, government requires access to finance. It is difficult to find sources of revenue which are "non-distorting".

The classic lump-sum tax (such as the "head" tax) approach to raising revenues in a non-distorting manner in efficiency terms may well constitute a regressive tax, and thus be in conflict with the distribution function of government. It is unlikely that "corrective taxes" – discussed in the preceding section and included under the allocation function – will raise sufficient revenues to compensate for the distortions as well as to finance the provision of public and quasi-public goods. Additional revenues will have to be raised, and these will (in principle) be applied according to the one or both of the two classic principles of taxation:

(a) The benefit principle, which states that citizens should pay taxes according to the benefits they receive from public sector activity; and
(b) The "ability to pay" principle, which states that citizens should be taxed according to their ability to pay.

These principles of taxation imply that taxes are unlikely to be "neutral" – ie. non-distorting in the pure efficiency sense. Indeed, some taxes may be imposed for "corrective" reasons to meet income distribution objectives. Similarly, conflict will exist between economic efficiency and the government's objectives of stabilisation and growth.

Because of these fundamental conflicts, we do not consider it feasible to follow the "first best" approach of correcting for distortions in terms of allocative efficiency only – the attitude taken in the simplified approaches to public intervention and to project economic analysis addressed in most manuals, guidelines, and training activities directed at practitioners. In this simplified approach, the term "first best" is often used to refer to cases in which the shadow prices would have been estimated in terms of equilibria which would exist after optimal correction of all distortions; while the term "second best" is often used to refer to prices which do not assume that these corrections have occurred, or will occur.

In this volume, we use the term "second-best shadow prices" in the simplistic sense implied in the preceding paragraph, while bearing in mind the general problem of second best implied by the still-developing theory of optimal taxation.

A1.4. THE FOREIGN EXCHANGE NUMERAIRE

***Summary**: In agricultural projects, the issue of the exchange rate can be avoided by working in a foreign exchange numeraire rather than the willingness to pay (WTP) numeraire. The foreign exchange numeraire requires that non-traded good be valued in terms of their indirect impact on foreign exchange, while traded goods is valued in terms of their direct effect on foreign exchange. Thus, in this numeraire all goods and services are treated as either directly or indirectly traded.*

Calculating the foreign exchange impacts of non-traded goods requires either tracing down the direct and indirect foreign exchange used in producing those goods, or finding traded goods for which the non-traded goods are substitutes. This tracing will usually be possible in agricultural and industrial projects, though not necessarily in water and sewerage or urban services projects.

In the (perhaps, perverse) value system of economics, the end objective of all economic activity is consumption. We said in preceding chapters that foreign exchange can be used for consumption purposes in the sense that it can buy additional consumer goods for the society (or producer goods which will contribute to future consumption). We can convert this foreign exchange into consumption values by using some variant of a shadow exchange rate, or a standard conversion factor.

Obviously, if we can convert foreign exchange into willingness to pay values (or domestic consumption values), then we can use the reverse process to convert domestic consumption values into foreign exchange. In other words, we can turn the numeraire around and express it in foreign exchange – rather than in willingness to pay terms – and we will still be measuring economic efficiency.

One advantage of the generic foreign exchange formulation of the economic efficiency numeraire is that it is easier to understand what it is that is being counted. Units of foreign exchange tend to be more easily understood than are units of consumption valued at what the market is willing to pay for them. By the same token, the foreign exchange numeraire is also easier to explain to politicians and administrators.

A1.4.1 CONVERTING NONTRADED GOODS TO THE FOREIGN EXCHANGE NUMERAIRE

In the foreign exchange numeraire, the CIF and FOB prices of traded goods – or their parity price equivalents – will already be expressed in foreign exchange (Parity prices are discussed in Gittinger, 1982: 78-83.) The problem then will be to convert the non-traded goods into foreign exchange equivalents. In each of the two numeraires discussed herein, the problem lies in accurately reflecting the other category of goods in the selected numeraire – and to do so consistently. In other words, in the willingness to pay formulation, the problem is to convert traded goods values into a valuation system comparable to that of the non-traded goods (ie convert foreign exchange into willingness to pay).

From the preceding paragraphs we know that this is done by determining the foreign exchange impacts of the traded goods and then calculating a consumption value equivalent for the foreign exchange. In the generic foreign exchange formulation, in contrast, the problem is the opposite: it is to convert the non-traded goods into equivalent foreign exchange impacts. To do this, two different approaches are used, depending upon whether the non-traded item being valued is a project input, or a project output.

Non-traded Project Inputs. In applying the foreign exchange numeraire, project inputs normally will be converted to foreign exchange by tracing the foreign exchange used directly and indirectly in producing the project inputs – ie. by breaking the project's inputs down into their inputs, round after round, *ad infinitum*.

When the process is completed, we will be left with direct and indirect foreign exchange impacts, non-traded labour, and land (ie natural resources). The foreign exchange valuation process will then be completed by converting the non-traded labour and land into foreign exchange and adding this foreign exchange costs to the direct and indirect foreign exchange costs of the other direct and indirect inputs. The procedure for converting labour and land to foreign exchange equivalents is discussed in a separate section.

What is important is to remember that, for non-traded project inputs, the approach involved is to convert them to foreign exchange by tracing the inputs of the inputs backward in the transaction process, round after round, until there are no non-traded items of any significance left to be broken down.

Non-traded Project Outputs. Non-traded project outputs are converted to foreign exchange in a different way. They cannot be traced backward, round after round, as are the non-traded inputs: To do so would make no sense. Rather, they are converted to foreign exchange impacts by determining the traded goods for which they substitute in domestic consumption.

For example, it may be determined that non-traded vegetables produced by a project actually substitute in consumption for imported wheat. That is, had the project not increased the output of vegetables, the farmers would have consumed bread instead. Since the country was a net importer of wheat, the bread consumption would have led to increased imports of wheat. Or by providing vegetables for on-farm consumption, farm families may eat more vegetables and less rice, and the project may release domestic rice production for export. Each of these alternatives would involve foreign exchange impacts brought about by the project's production of non-traded vegetables.

The point to remember is that, in the foreign exchange numeraire, non-traded agricultural outputs ultimately substitute some traded goods. We must find those substitutes so that we may use their border prices in deriving the foreign exchange impacts of the non-traded goods output produced by die project.

A1.5. PROJECT ANALYSIS, FINANCIAL FLOWS AND "REAL" RESOURCE FLOWS

***Summary**: Economic efficiency deals with the maximisation of society's consumption over time. Financial prices which lie behind financial cash flows may not accurately reflect the value of society of the real resource flows that are involved. Likewise, certain reporting formats – such as income statements – may not accurately reflect the timing of those flows. To analyse economic efficiency of projects, a special cash flow format is used; adjustments are made to the financial flows to make the cash flow statement better reflect real resource flows. The adjustments include deleting financial flows that do not reflect resource flows, incorporating implicit costs, and removing "sunk" costs while retaining "incremental" costs.*

We have said that to an economist the function of economic activity is to generate consumption. We have also said that society's consumption is affected by the amount of final goods and services that are available; and that one widely accepted way to measure the value of those goods and services to society is to estimate it's willingness to pay for them.

An economic activity that has not created a final good, or provided a final service, for consumption by society cannot be aid to have generated an economic benefit to society. (Note, however, that we will normally take the willingness to pay for an intermediate good as a measure of the consumption value of the final goods that the intermediate good will eventually be used to produce.) Similarly, any economic activity that uses a resource, which otherwise might have been used for consumption, has created a cost to society.

Ideally, in conducting project economic analysis, we would like to value all project outputs in willingness to pay values, and account for these outputs at the time the consumption takes place. Likewise, we would like to cost all project *inputs* in terms of willingness to pay for the inputs at the time the forgone consumption would have taken place.

The Cash Flow Format: The formats that we use in project economic analysis – as well as the valuation conventions that we apply – are meant to achieve the two objectives mentioned in the preceding paragraph. To accomplish the latter objective (ie the timing of the accounting), we set up the project accounts in a cash flow format. The cash flow format allows us to reflect the actual resource flows much more accurately (in terms of the objectives mentioned earlier) than would an income statement format. (The process of building up and using a financial cash flow for a farm is discussed in Gittinger, 1982: 127-140, under the heading of "Farm Budget". The farm budget is a form of financial cash flow statement.)

Weaknesses of the Income Statement Format. The issues addressed in this section are most problematic in traditional financial accounting as used in processing industries. Some of the issues arise in farming activities, however. Let us review briefly the drawbacks to using traditional financial statements in appraising projects (see Gittinger, 1982, Chapter 5). The income statement misrepresents actual resource flows in several ways:

First, several expense items in the income statement show costs at a time other than the point in time at which resources were actually taken away from their alternative uses. These expense items include:

- *Depreciation expense.* An accounting convention which accounts for fixed asset costs over a number of years rather than reflecting the costs when the resources are tied up.
- *Amortisation expense*. An accounting convention which accounts for intangible fixed assets – such as patents, licenses, and pre-operating expenses – over a number of years, rather than reflecting their costs at the time they are incurred.

- *Resource depletion allowance.* An accounting convention which shows the decrease in the value of land as the resources are extracted, rather than showing the decrease by taking a lower salvage value for the land at the end of the project when the land is returned to non-project use.

Second, in calculating the "cost of goods sold", the inventories of finished goods and inventories of goods in process are valued at cost (including an allocation for overhead costs, if absorption costing is used) or at market value –whichever is lower at the time the income statement is prepared.

Inventories are then subtracted from operating expenses to determine the cost of goods sold. This procedure is equivalent to putting a value on the inventories. However, this accounting approach misrepresents real resource flows since:

(a) Producing inventories ties up resources just as does producing goods for consumption (therefore, these costs should be reflected in the financial accounts); and
(b) Inventories have no value to society until they are consumed.

The cash flow format should be set up to fully cost all production, but to value the production only when it is actually sold. It should show no economic value for any inventory, and it should cost all resources when they are taken away from other uses. (Inventories of raw materials should be cost in full at the time these inventories are built up.) In farm accounting, this problem is dealt with, in part, by using the "time-adjusted cash flow" approach (Schaefer-Kehnert, 1978).

Third, income statement expenses show only what economists call "explicit" or financial costs. They do not include the "implicit" or opportunity costs of resources already owned. In project cash flow analysis, we should set up financial cash flows "with" and "without" a project; then, we should subtract the "without project" cash flow from the "with project" cash flow in deriving the "incremental cash flow". This procedure implicitly cost the resources which have not already been cost explicitly in setting up the "with project" cash flow. (Forecasts of the state of the economy without the project are necessary for properly shadow pricing the benefit and cost streams – particularly when a country is at the margin of self-sufficiency in a commodity.)

A1.5.1 POINT OF FIRST SALE VALUATION

The convention of valuing all outputs at the point of first sale has two objectives:

(a) To avoid having the project take credit for the value-added that occurs at later stages in the processing; and
(b) To account for the timing of consumption as closely as possible.

For project outputs that are processed further, this practice tends to overvalue them slightly. (Since these outputs will be recorded earlier in the accounts than the point at which they are actually consumed, they will not be discounted heavily when the accounts are finally subjected to discount cash flow analysis. Except for such economic activities as producing steel for shipbuilding, this distortion in timing is generally not worth worrying about.)

We need to note that in the point-of-first-sale convention, project output which goes into finished goods inventory has no economic value; this is because economic value does not occur until the item is actually consumed. In economic analysis, as a matter of convenience, consumption is assumed to take place when the output is sold.

A1.5.2 CASH VERSUS CREDIT SALES

In economic analysis, there is not need to differentiate between cash and credit sales, and it is irrelevant when, or even whether, payment was made. The difference between cash and credit sales is taken care of in the financial cash flow statement by placing all credit transactions at the bottom of each flow table (ie short-term credit transactions, such as financing of accounts receivable, etc) so that the top part of the financial cash flow statement (or the farm budget) show all transactions as though they were cash transactions. In making the economic cash flow statement from the financial cash flow statement, we normally ignore the credit transactions at the bottom of the statement. We work only with the top part of the financial cash flow statement.

The convention of ignoring credit transaction may be altered for projects in which:

(a) The financing is obtained from sources external to the country; and
(b) The financing is "tied" to that particular project.

Generally, these conditions hold true only for projects involving foreign private financiers (eg in the natural resources sector these would include timber growing and/or harvesting, mining projects, some agroindustrial export activities, etc). We normally assume that bilateral and multilateral project finance is part of a programmed package of assistance which would be available for alternative projects in the event that a project in the programmed set was found unacceptable upon appraisal.

However, most of the agricultural projects that would be appraised by agricultural line agencies would not be of the tied-financing type. Thus, it is a common practice to ignore these cases in regular agricultural projects, and to ignore all credit transactions.

Normally, cases involving tied financing should be appraised by a joint team comprising staff from both the agricultural line agency and from one of the central economics agencies in the country, such as the Planning Office and the Ministry of Finance. (In the projects financed by the International Finance Corporation, an affiliate of the World Bank that focuses on the private sector, the analysis of financial flows is routinely included in the process of completing the economic analysis. This contrast with agricultural projects funded by the Bank's other affiliates that work primarily with the public sector.)

A1.5.3 CASH VERSUS REAL TRANSACTIONS

A Common Denominator of Resource Flows. We have said that we are interested in real resource flows. This interest is not changed by the fact that we use currency units counted in willingness to pay terms to measure resource flows. This practice easily misleads non-economists to think that it is the money flows that are important in project economic analysis. (Note that the funds flow analysis is critical in financial planning for the project, but it is a financial analysis concern for the project and for each farmer: it is not a concern of the economic analysis, except in the way in which funds flows affect individual behaviour, and thus the expected real outcomes of the project. The financial analysis problems are important, and they must be addressed in parallel to the economic analysis issues. Obviously, both sets of issues must be dealt with in planning viable projects.)

That misunderstanding among non-economists is an unfortunate side-effect of our need for a common denominator for measuring the resource flows. Perhaps, we could avoid this misunderstanding by instead measuring all resource flows in equivalents of one ton of wheat and using a decimal version of "wheat-tons" as our common denominator; but, this would add another tedious – and probably equally confusing – conversion problem to our calculations. (Energy planners often use a ton of coal equivalent (TCE) as a common denominator.)

Resource Flows versus Transfer Payments. The use of currency units in measuring relative resource flows in the project economic analysis is simply a convenience: The currency unit gives us a convenient common denominator for adding and subtracting the sums of the resource flows. In some cases, the currency flow represented by the financial price will be the same as the number of currency units that represent the resource flow. In other cases, the financial flow will not be the same as our common denominator measure of the resource flow.

One good example of the latter case is the payment of a "head tax", which governments have charged every citizen, on occasion, as a way of collecting revenue. In that case, currency clearly does flow from the taxpayer to the government; but there is no underlying resource flow that we need to use currency units to measure. In this case, we would simply ignore the financial flow in the economic analysis, since it does not represent any real resource flow.

When the currency flow is different from the actual resource flow, we define the difference between the two as a transfer payment. The term "transfer payment" indicates that the financial price that is being paid does not represent the actual values of the resources involved; thus, the distorted price has the effect of transferring purchasing power in one direction or the other – ie. away from the purchasers if the financial price is higher than the real resources involved, and toward the purchasers if the financial price is unduly low.

A1.5.4 EXPLICIT AND IMPLICIT COSTS

Explicit or Financial Costs. Costs which occur "out of pocket" are termed explicit costs. These costs are recorded in traditional financial statements as expenses incurred by the enterprise in carrying out its business. Explicit costs are associated with purchased inputs, hired labour, borrowed capital, and so forth. Payments for inputs made directly to the supplier cause the enterprise to incur explicit costs.

Implicit or Opportunity Costs. "Opportunity costs" represent the benefits forgone. These costs also are real costs, for they represent something that is given up as a result of deciding to take one course of action instead of another. For example, a farmer may withdraw his savings from the cooperative saving bank, when the money was earning 6 percent interest per year, to invest the money in a new sprayer. The cost of the new sprayer, then, would include both explicit and implicit cost elements. The explicit cost element would be represented by the purchase price of the sprayer, while the implicit cost element would be represented by the annual interest that would be lost as a result of withdrawing the savings from the bank.

Traditional financial accounts include only explicit costs. However, good financial decision-making should take into account both implicit and explicit costs associated with the decision. Economic analysis always takes into account both explicit and implicit costs. In agricultural project analysis, both the financial and the economic accounts are normally set up in such a way that all items that have not been cost explicitly will be cost implicitly. The implicit costing is done by subtracting the "without project" cash flow from the "with project" cash flow to derive the incremental cash flow.

All of the purchased inputs that are used in producing he farm's output in Table 1 are cost explicitly – both he "with" and the "without" project cases. However, the non-purchased inputs are not cost explicitly because here are no "out of pocket" costs associated with providing family labour, the farmer's land, and the hand tools and other implements that the farm family already owns.

However, we must note that without the project, the farm family would have had a net cash flow or R523. This R523 would have been left over after the purchased input had been paid for, and it would represent the total of the net inflows that would be available to compensate for the family's labour, land, capital, and the other factors of production.

If the farm represented in Table 1 participates in the proposed project, then the farm family will forgo the "without project" returns of R523 in favour of whatever it can earn for its land, labour and capital by using thee in the project. The implicit cost of using these factors in the project will be the income forgone by not using them outside the project; this is shown in the table as the "without project" net cash flow of R523. By subtracting the R523 in deriving the incremental net cash flow attributable to this farm's participation in the project, we have implicitly cost the factors of production owned by the farm family.

Note that we can implicitly cost non-purchased inputs only if the "without project" column in Table 1 includes all family income without the project for example, off-farm income with and without implicitly costing family labour correctly.

Note also that the table will impute a zero cost for family leisure. In other words, if family labour input without the project is 600 person-days per year, while family labour input with the project increases to 700 person-days per year, Table A1.1 will show an implicit cost of zero for the 100 extra days of labour. The reason is that there will have been no without-project income attributed to that extra labour.

Table 1 will not be able to count implicitly he "psychic cost" of having o work more days per year. The costing of incremental family labour (other than the cost attributable to foregoing compensated off-farm work) will have to be handled in side calculations deriving from the labour budget calculations.

Opportunity Costs and Shadow Prices of Inputs. In project economic analysis, the economic cost of project inputs will be derived from their opportunity cost. The opportunity cost will be measured in terms of the impacts hat those inputs would have had in their non-project alternative use (ie "without the project" use). We have used the term "impacts" rather than "income" or "benefits", because the measure of he cost of he inputs will depend upon the numeraire being used in the economic analysis.

Incremental and Sunk Costs: The analysis of a project (in contrast to ht of a company) is based on the analysis of "decision-related" impacts – ie. the decision of whether or not to implement the project. Those impacts can be divided into two groups:

(a) Positive impacts called "benefits"; and
(b) Negative impacts called "costs".

Example: Cash Flow for Model Farm. Year Four.

Table A1.1: Implicit and Explicit Costing in Cash Flows in Rupees

	Without project	**With project**
Inflows		
Beans	200	280
Maize	300	350
Lettuce	80	120
Outflows		
Purchased seed	5	15
Fertiliser	10	25
Pesticides	2	20
Ploughing services	5	10
Hired labour	25	40
Other inputs	10	10
Net cash flow		
Without project	523	630
Incremental		
net cash flow		107

Note: *The farmer's land, labour, and the inputs already owned are cost implicitly by subtracting the "without project" net cash flow from the "with project" net cash flow. All purchased inputs are cost explicitly by showing their costs explicitly in the table.*

By "decision related" we mean that the impacts will not occur if we make one decision, while they will occur if we make the alternate decision. This is the same issue as the "incremental" analysis discussed in Gittinger (1982: 315); and it is the same as the issue of "with project" versus "without project" analysis. "Incrementality" is a critical issue in assessing project benefits and costs.

Traditional financial accounts, designed for the analysis of companies rather than of projects, do not differentiate between sunk costs and incremental costs. While it is possible in some accounting systems to make a delineation of costs which are related to production as opposed to those which are not, the basic financial accounts are not set up for that purpose. For example, a simple analysis of sunk and incremental costs using the economist's distinction between short-run fixed and variable costs can be carried out by using the financial statements. But unless "direct cost accounting" is used rather than the traditional "absorption costing", it can be difficult to rearrange the information for such a purpose.

In fact, two sets of accounts are normally set up in project planning:

(a) One set of "incremental" accounts for the project analysis itself; and
(b) A second set of accounts for the analysis of the company that implements the project.

The second set uses the approach of traditional financial statements, or of farm enterprise accounts, in the case of agricultural projects.

The issue of sunk and incremental costs arises at several points in project analysis. Gittinger (1982: 55) discusses one such application. We are concerned here with the use of these cost concepts in calculating "supply-price conversion factors", which will be dealt with in following chapters. In that application, the concept of sunk and incremental costs will affect the way overheads and profits are dealt with in calculating the incremental economic costs of supplying project inputs, assuming that we work from the kinds of cost data that normally are provided by traditional financial accounts.

ANNEXURE 2: SHADOW PRICES AND THE MEANING OF CONVERSION FACTORS

Summary. *After a financial cash flow for a project is derived and initial adjustments are made, then other values in the cash flow must be adjusted for the remaining distortions in "border" and "domestic" prices. These adjustments may be made by multiplying the financial values by appropriate "accounting ratios", "conversion factors", or "shadow price factors" – all of which refer to the ratio of the economic value to the financial value of items in the project cash flow. The denominator of the ratio will be the same no matter which method is used for analysing economic efficiency.*

However, the numerator will vary depending upon the numeraire used – whether the values are denominated in border or domestic prices, and whether first-best or second-best shadow pricing is being used. The ratios may be calculated for both traded and non-traded goods. In calculating the ratio for a specific good or service, both the border distortion and the domestic distortion will be corrected in estimating the numerator. Conversion factors generally refer to economic valuation done in border price terms, while shadow price factors usually refer to valuation in domestic price terms.

Either denomination may be used regardless of whether we conduct "partial border pricing" of "complete border pricing". The farmer refers to border pricing which make extensive use of the standard conversion factor (SCF), while the latter refers to border price calculations involving detailed tracing of the impacts that non-traded goods have on traded goods.

A2.1 SHADOW PRICES, ACCOUNTING PRICES, FINANCIAL PRICES, AND ACCOUNTING RATIOS

The terms "shadow price", "accounting price", and "economic value" are often used interchangeably in project economic analysis. Though each term tends to have historical linkages with one system of appraisal or another, each term means basically the same thing.

Our objectives in deriving these economic values, or accounting prices, are to:

(a) Develop a measure of real resource flows which excludes financial flows that do not represent real resource flows; and
(b) Show the measure of resource flows in units of our numeraire.

We would expect the set of economic values to be different for each possible definition of the numeraire.

In conducting project economic analysis, we would like to have an economic accounting price for each particular input and output. Gittinger (1982: 243-284) goes into some detail regarding the derivation of economic values, based on the willingness to pay calculation at both the domestic price level and at the border price level. Thus, Gittinger discusses the steps involved in deriving two sets of economic accounting prices for a project. However, we must bear in mind that these two sets of economic accounting prices are closely related to each other; they differ only in the aggregate adjustment that takes place between the domestic price level and the border price level.

Thus, each of these two sets of economic values may be derived from the other set simply by dividing or multiplying by PREM, the "premium" or foreign exchange, discussed in part:

(a) The set of border price level (ie the SCF approach) economic values discussed in Gittinger (1982) may be derived from the domestic price level (ie the SER approach) economic values by dividing each of the SER-approach economic values by PREM.
(b) Alternatively, the SER-approach (ie domestic price level) economic values may be derived by multiplying each of the SCF-approach (ie border price level) economic values by PREM.

Once a set of economic accounting prices has been derived to fit the numeraire that has been defined, each economic price can be compared directly with the corresponding financial price for each item in the project cash flow. In some cases, the economic values will be lower than the financial values; in other cases they will be higher. The interpretation of this difference will depend to some extent upon what numeraire is used and the price level at which the numeraire is denominated (eg the domestic price level versus the border price level). In each case, however, the difference between the financial price and the economic accounting price will indicate the price distortions affecting that particular good or services.

Often, we will find it convenient to make a set of ratios from the sets of accounting and financial prices – ie. to divide each economic accounting price by the financial price of the cash flow item. This practice can be helpful because once these ratios are known they may be used to convert other financial values into economic values. This capability greatly facilitates the process of converting the project financial cash flow into a project economic cash flow.

The ratio of economic value to the financial value is known by several names: accounting ratios, accounting price ratios, conversion factors, or shadow price factors. Each name means basically the same thing (though some of these ratios have been developed using specific shadow pricing approaches, and thus continue to be associated with those approaches).

The term "conversion factor" has come to be associated with a shadow pricing process in which financial prices are converted to border price calculation in either the willingness to pay numeraire or in the foreign exchange numeraire. The conversion factors were popularised by the OECD Manual; thus, the term tends to have a somewhat stronger association with border price calculations done in the foreign exchange numeraire than with border price calculations done in the willingness to pay numeraire; the approach discussed in Gittinger (1982).

Nevertheless, the term "conversion factor" has tended to be used in applying both the foreign exchange and the willingness to pay numeraires in border prices. In all these applications, the conversion factor will sometimes be referred to as the ratio of the economic value over the financial value of the item, and sometimes it will be referred to as the ratio of the border value over the financial value of the item. We will clarify the latter definition of the ratio in the following sections.

The term "shadow price factor" is associated with the conversion of financial values into economic values in a willingness to pay numeraire calculated at the domestic price level. We are not defining hard and fast rules for these particular terms: rather, we are reporting on observed tendencies to associate particular terms with particular numeraire denominations. We point out these tendencies because of the analytical advantages provided by clear communication. The substance of this discussion is that it is generally best to use economic analysis terms in a way in which others are accustomed to using them.

A2.2. THE CONCEPT OF BORDER PRICES

"Border price" and "border pricing" are important terms in project economic analysis and in the analysis of pricing and trade policies. "Border price" is a more accurate term than "international price" that is sometimes used as an alternative. Border prices are specific to a particular country, whereas it is not clear what the basing point is for quotations in international prices. However, even the term border price needs to be made more specific to be used in a practical context.

There are two border prices for each product at each port in the world. One is the CIF (cost, insurance and freight) price, which relates to products imported through that port; the other is the FOB (free on board) price, which relates to products exported through that port. (CIF and FOB prices are discussed in Gittinger (1982: 78-83). In countries having more than one major port, it may not be sufficiently specific to use the CIF price without saying which port, or what part of the country, you are talking about. This is particularly true in a country such as Saudi Arabia, for example, which has major ports fronting on two seas, or in a country such as Brazil with distances totalling hundreds of kilometres between ports.

While the terms "CIF price at Mombassa" or "FOB price at Karachi" are more specific than the border price, in project appraisal we find it useful to get even more specific than that. Import and export parity prices represent more specificity, because they allow us to calculate border-price-related prices at various points within the country – eg at the project gate, at the farm gate, at the market, and so forth. Gittinger (1982: 269-271) uses the parity-price approach to deal with border prices. These parity prices usually are calculated at the project gate, or at the farm gate.

In common usage, the term "border pricing' may refer to one of the following two applications:

(a) The process of deriving a border price for a particular good or service (ie the CIF, FOB or the good" equivalent parity price); or
(b) The process of conducting project economic analysis by using either the foreign exchange numeraire or using the willingness to pay numeraire denominated in border prices.

We know from Gittinger (1982) that parity prices may be derived in either financial or in economic terms. The financial parity price calculation is used largely in market analysis, while the economic parity price calculation is used in project economic analysis and in policy analysis – particularly in applications involving sectoral pricing policies.

As a result of the importance given to border prices in the OECD Manual, the terms "border price" and "border pricing" have come to be closely associated with the methods of analysis presented in the original and in the revised versions of the OECD Manual. Economists commonly use border prices and border pricing in referring to the application of Little and Mirrlees' method of analysis – ie. economic analysis done in border prices using a foreign exchange numeraire. Also note that, since the initial presentation by Little and Mirrlees was based on first-best shadow pricing, it is often assumed that the term "border pricing" refers to applications using first-best shadow prices. In later editions of the work – published by Heinemann Books – Little and Mirrlees took a position similar to that of Squire and van der Tak: the decision was left to the project appraiser in deciding whether to use first-best or second-best shadow prices. Many economists will be prone to assume that anyone else's use of these terms also implies that the OECD method of economic analysis is being used.

A2.2.1 CONVERSION FACTOR IN THE WILLINGNESS TO PAY ANALYSIS

In the preceding paragraphs, we defined a conversion factor (CF) as a ratio of economic value to financial value of a particular item. We indicated that each item in a project cash flow, in principle, has its own conversion factor. Thus, we may define a "set" of conversion factors as a group which includes conversion factors for every good and service in the country. There would be a different set of CFs for every numeraire; and every item in that set would represent the ratio of the economic value to the financial value of a particular good or service in the numeraire that was being used.

In using the willingness to pay numeraire, foreign exchange may be treated as a "commodity" which has the capability to generate domestic consumption value. That capability may be expressed by the weighted average value of the consumption basket of traded goods that the foreign exchange represents. (Note that the basket may be made up of different aggregations of goods, depending upon how the calculation is being used. This point will be discussed further in later sections.) This notion of a basket of goods is the normal sense in which the premium on foreign exchange (PREM) is calculated and used. In project appraisal applications, PREM is used to adjust for the distortions between relative consumption values of traded and non-traded goods. In other words PREM represents an adjustment to the financial prices that we must make in dealing with the distortions caused by trade policies of the government, ie. border distortions as opposed to domestic distortions. It is not the only adjustment that will have to be made, since distortions resulting from trade policies are not the only distortions that exist in the economy.

In converting financial prices to economic values, there will generally be two sets of adjustments that need to be made. The first is an adjustment to border distortions. This adjustment would be to the financial prices to correct for systematic distortions between traded and non-traded goods (sometimes treated as distortions in the exchange rate). These distortions occur at the border of the country and are caused by the country's trade policies, such as those relating to import tariffs and subsidies, export subsidies and taxes, and import and export quotas. It is this set of distortions that the PREM calculation is designed to capture in the approach discussed in Gittinger (1982).

This set of adjustments is made in either of the following two ways in the willingness to pay numeraire:

(a) *The SER approach.* By applying the shadow exchange rate (SER) to all border prices of traded goods, while using domestic shadow prices (willingness to pay values) for the non-traded goods. This procedure will be followed if the results are denominated at the domestic price level, ie. using the SER, in the terminology used by Gittinger (1982).
(b) *The SCF approach.* By applying the shadow conversion factor (SCF) to the shadow priced values of non-traded goods, while applying the official exchange rate of the border prices of traded goods. This procedure would be followed if the results are to be denominated in border prices, ie. using the SCF, in the terminology used by Gittinger (1982).

The second is an adjustment to domestic distortions. This adjustment would be made to the financial prices to correct for distortions that occur within the country. The internal distortions could include, for example, the effects of minimum-wage laws on the price of labour and of monopoly elements on the price of locally made machinery. These prices will be adjusted in the economic analysis by applying the valuation principles discussed in Gittinger (1982). For example, in the case of unskilled labour, a shadow price might be derived based on the marginal value produced (MVP) of labour in the alternative use to which that resource would be put "without" the project.

If we use accounting ratios or conversion factors in project economic analysis, they should assist in converting financial prices to economic values. Our conversion factors may be calculated so that they incorporate both steps – adjusting for distortions between traded and non-traded goods and adjusting for distortions among non-traded goods – into one conversion factor; or, they may be calculated so that border distortions are handled separately from domestic distortions.

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Generally, in applying the foreign exchange numeraire and the willingness to pay numeraire in border prices, the conversion factors will be calculated to include corrections for both the border distortions and the domestic distortions at the same time. For example, in developing a conversion factor for unskilled labour, we might find the following kind of calculation performed:

Assume: MVP of unskilled labour in alternative work = R10/day
Project wage for unskilled labour = R15/day
PREM = 1.25; and
OER: R10 = $1

Since: SER = PREM x OER

Then: SER: R12.5 = $1, or the same SER may be written as:
SER: R10 = $0.80; and

$$SCF = \frac{1}{PREM} = \frac{OER}{SER} = 0.80$$

Further: Shadow wage rate (SWR) = MVP = R10/day
Economic border value of unskilled labour = SWR x SCF
Economic border value of unskilled labour = R10 x 0.8
= R8/day; and
Conversion factor for unskilled labour = Cf_{ul}, where:

$$Cf_{ul} = \frac{\text{Economic value}}{\text{Financial value}} \text{; then:}$$

$$= \frac{\text{R8/day}}{\text{R15/day}} = 0.56$$

These steps may be shown in more general terms as follows:

$$NB = [(T_o - T_i) \times OER] + (s.a.N_{to} - s.b.N_{ti}) \qquad \text{(A2.1)}$$

Where:

NB = Net benefits from projects for year n

T_o = FOB value of exported project output for year n (assumed to be only one output)

T_i = CIF value of imported project inputs for year n (assumed to have only one non-traded output)

N_{to} = Financial value of nontraded project output for year n (assumed to have only one non-traded output)

N_{ti} = Financial value of non-traded project input for year n (assumed to have only one non-traded input)

s = SCF

a = Shadow price factor for N_{to}

b = Shadow price factor for N_{ti}

Shadow Price Factors versus Conversion Factors. The shadow price factor is defined as the item'' shadow price in domestic terms, without having been corrected for border distortions (eg the MVP of unskilled labour in the preceding example). The shadow wage rate (SWR), for example, is the shadow price of labour defined in domestic price terms, without having corrected for border distortions. The ratio of the SWR to the financial wage would give the shadow price factor for labour. To get the conversion factor for labour, we multiply the shadow price factor for labour by the SCR, or by the conversion factor for the output that labour would have produced in its alternative employment without the project, in the “compete border pricing” approach discussed below.

We may thus define conversion factors for each of the inputs and each of the outputs as follows:

$$CFT_o = \frac{\text{Border price of } T_o}{\text{Financial price of } T_o} = \frac{T_o}{T_o + e} \qquad (A2.2)$$

Where: CFT_o = Conversion factor for T_o

e = Export subsidy on T_o; (already excluded with other direct transfers)

$$CFT_i = \frac{\text{Border price of } T_i}{\text{Financial price of } T_i} = \frac{T_i}{T_i + t} \qquad (A2.3)$$

Where: CFT_i = Conversion factor for T_i

t = Import tariff on T_i; (already excluded with other direct transfers)

$$CFNT_o = \frac{\text{Economic value of } NT_o}{\text{Financial value of } NT_o} = \frac{s.a.NT_o}{NT_o} = s.a \qquad (A2.4)$$

Where: $CFNT_o$ = Conversion factor for Nt_o

$$CFNT_i = \frac{\text{Economic value of } NT_i}{\text{Financial value of } NT_i} = \frac{s.b.NT_i}{NT_i} = s.b \qquad (A2.5)$$

Where: $CFNT_i$ = Conversion factor for Nt_i

We can note from the preceding paragraphs that – in the border price version of the willingness to pay numeraire – the conversion factors for the non-traded goods will be their domestic shadow price ratios multiplied by the SCF; while the conversion factors for the traded goods will be their CIF and FOB values divided by their financial prices.

The annual net benefit equation can be rewritten as follows:

$$NB = [(T_o - T_i) \times OER] + [(a.Nt_o - b.Nt_i) \times s] \qquad (A2.6)$$

and we would get the same absolute value for net benefits (NB). This is true mathematically; however, in practice, we would have to be extremely careful that we reflected all the indirect foreign exchange that is involved in producing the non-traded input (Nt_i). Otherwise, these two methods would not correspond to each other. For this and other reasons, it is a general practice to deal with both the domestic and the border distortions in the same calculation in estimating conversion factors.

A2.2.2 CONVERSION FACTOR IN THE FOREIGN EXCHANGE NUMERAIRE

In applying the foreign exchange numeraire, our objective is to determine the foreign exchange impacts of all project inputs and outputs. This process is possible because economics teaches us that:

(a) All markets are interrelated; and
(b) All inputs and all outputs, in principle, have substitutes.

Note that this statement may not apply to projects in the urban sector where the project's non-traded outputs might not have substitutes (eg urban water supply). Directly or indirectly, some of these substitutes are traded goods; thus, non-traded goods have an impact on the country's foreign exchange availability. In addition, production processes for all non-traded goods use traded goods as inputs, either directly or indirectly.

In the foreign exchange numeraire, the conversion factor would be defined as the ratio of border values to financial values, where the border value of each item would represent the impact that the good or service has had on foreign exchange. Generally, for project inputs, the foreign exchange impact would be negative; while, for outputs, it would be positive.

If the foreign exchange numeraire were denominated in local currency (ie. in units of foreign exchange which had been converted into local currency at the OER) then each conversion factor would be a ratio of two local currency values, ie. the ratio of the economic value in local currency divided by the financial price in local currency. However, if the foreign exchange numeraire were denominated in foreign currency, ie. in units of foreign exchange which had not been converted into local currency, then each conversion factor would be the equivalent of a specific exchange rate for the item whose economic value (foreign exchange value) was being determined, ie. the ratio of the economic value in foreign currency divided by the financial value in local currency.

Some proponents of the foreign exchange numeraire argue that this numeraire is superior to the willingness to pay numeraire. They take the position that it is more accurate to use several shadow exchange rates (SER) than to use only one. However, this perceived increase in accuracy provided by the foreign exchange numeraire is a misperception on their part. The issue is not between using one SER or using several factor-specified SERs; rather, it is an issue of how far we are prepared to trace the direct and indirect impacts that each project has on the economy. In other words, the issue is whether we work under the assumption that all impacts on non-traded goods can be traced to impacts on traded goods.

If we are equally diligent in applying the willingness to pay numeraire and, if we make the same assumptions abut the interrelationships between markets, then the same number of specific SERs will be generated in applying the willingness to pay numeraire as will be generated in applying a foreign exchange numeraire. By denominating either of these numeraires in a foreign currency, instead of the local currency, we will change the accounting ratios for project inputs and outputs into specific SERs for each of those inputs and outputs. It does not matter which of these two numeraires we choose to state those impacts in, so long as we make the same assumptions about market interactions.

The point in the analysis at which the issue of diligence and the assumptions of the appraiser and the accuracy of the two economic efficiency numeraires become critical occurs in dealing with non-traded inputs and – in particular – non-traded outputs for which demand-price conversion factors would be obligatory in the foreign exchange numeraire (see the next section for details).

In the applications of the willingness to pay numeraire denominated in border prices, the typical practice is to use the SCF in place of demand-price conversion factors for inputs and to use the SCF in place of demand-price (CFs for outputs). In the foreign exchange numeraire, the need for tracking the direct impact on traded goods is a bit more obvious and, perhaps, a bit more likely to be undertaken as a result. Thus, in practice, the comparative accuracy of the two numeraires comes down to a question of whether we use the SCF to derive the demand-price conversion factors rather than using the CFs for the traded goods that are expected to be affected by the project's use of non-traded inputs which are not supply responsive, or which are used in the production of non-traded outputs.

A2.2.3 PARTIAL AND COMPLETE BORDER PRICING

No matter what numeraire is used, the terms "conversion factor" and "accounting ratio" refer to the ratio of economic values divided by financial values. The conversion factors that you as the project appraiser will be applying will do basically the same thing: they will convert the project financial prices into project economic prices in terms of whatever numeraire is being used in the economic analysis – whether that numeraire be an economic efficiency numeraire in willingness to pay terms, or in foreign exchange terms, or whether it be some altogether different numeraire.

In the willingness to pay numeraire, there are two different ways in which economic efficiency analysis is applied, depending upon what assumptions we make about the interrelations between markets for traded and non-traded goods and services:

(a) Complete border pricing; and
(b) Partial border pricing.

In complete border pricing, the same assumptions are made about market interrelationships as those made in the foreign exchange numeraire. In other words, all markets are interrelated, such that impacts on non-traded goods can be traced to impacts on traded goods and vice versa. Since all goods are assumed to be traded goods – directly or indirectly – in this approach the calculation of PREM is not quite so critical. The reason is that all values will end up being adjusted by the same border distortion adjustment factor that is derived from PREM (ie the SER or the SCF).

In partial border pricing – this approach is often applied in practice – we work under the large implicit assumption that traded goods have an impact on foreign exchange, while non-traded goods may not necessarily have such an impact. In this approach, border prices for traded goods are converted to foreign exchange impacts, and the foreign exchange is expressed in willingness to pay values. The willingness to pay values for non-traded goods is then compared with willingness to pay values for foreign exchange in conducting the project economic analysis.

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In the partial border pricing method the calculation of PREM is very important, since it will be used to adjust the values between traded and non-traded goods. In this method, we compare the willingness to pay for the foreign exchange represented by the traded goods and the willingness to pay for the non-traded goods themselves. Note that this comparison may be made either at the border price level or at the domestic price level – the two approaches to economic analysis (the SER method and the SCF method) presented in Gittinger (1982).

If we eliminate the possibility of having truly non-traded goods (ie. assuming that all goods are either directly or indirectly traded) then the willingness to pay issue really comes down to a question of willingness to pay for foreign exchange, since every impact really involves foreign exchange directly or indirectly. In that case, the foreign exchange numeraire and the willingness to pay numeraire are applied in the same way, and the question in the willingness to pay application of the economic efficiency numeraire is whether we have the "right" values for the PREM and the SCF, which is the same as asking whether we have the right (SEF).

If all goods are traded either directly or indirectly in the foreign exchange numeraire, then exchange rate values become unimportant, because they will only be used at the last moment when all of the foreign exchange is moved from one currency denomination into the other; and since all values would be multiplied by whatever exchange rate is chosen, the final comparison will be unaffected. If we do not make unduly liberal use of the SCF in the analysis (ie. if we use CFI's instead) then the estimate of the SCF will not constitute a serious issue – though the accuracy of the estimates of the Cfi's will be important. Note that we can only make the forgoing statements in regard to applications which involve complete border pricing; they would not be true if we are talking about partial border pricing.

If the country has limited international trade and has no intention of changing those policies, then there is a good reason to question whether it makes sense to use a complete border pricing approach to project analysis, if we are not going to use the analysis as a bridge into policy-related discussions with policymakers. Such an environment would be most suited to the use of partial border pricing methods – in particular, partial border pricing using the SER approach. This may be viewed as the classics case for which the willingness to pay numeraire denominated in domestic prices makes the most sense. In this case most inputs and outputs would be de facto non-traded goods; the SER would not be used much in the project analysis and any slight errors in its calculation would not much matter and the most relevant measure of economic value would be the willingness to pay for the project's non-traded inputs and outputs (UNIDO Guidelines, 1972). Because of the issue of the sensitivity of the border prices discussed previously, the domestic price version of the willingness to pay numeraire would likely be a more appropriate method than any of the border pricing methods under these circumstances.

If the country has limited trade and is characterised by severe domestic distortions, then no method of economic analysis will be easy to apply, though any reasonable method could greatly assist the process of project planning, if applied diligently and if extended to include policy analysis. In particular, it will be practically impossible for non-economists to conduct any form of meaningful project economic analysis in a highly distorted economy. And even the economists who might attempt to conduct project economic analysis will have to expend a great deal of effort (as well as other resources) to gather the information needed to generate meaningful shadow prices. And yet, this is must the case in which the potential positive impacts from good economic analysis are the greatest – both project analysis and policy analysis. In all likelihood, such a country would be helped considerably by good economic policy analysis – if the analysis could have an impact on the country's conduct of economic policy.

In the current international environment, it is doubtful whether international aid agencies would provide stand-alone project financing for projects in such a high distorted economy. More likely, the aid agency would not be willing to finance projects at all unless major policy reform was undertaken. If project financing were undertaken, it would likely be done as part of a "sectoral", or "structural", reform package. Because of the increasing number of countries entering the category of the "thoroughly distorted", this kind of package is becoming increasingly important as a mode of project financing by the international aid agencies. These same factors also make it increasingly important that policy analysis be more routinely conducted as a counterpart of project analysis.

A2.3 CATEGORIES OF CONVERSION FACTORS

***Summary**: Conversion factors (CFs) are used to convert financial values to economic values in the project cash flow. CFs may be either "specific" CFs (abbreviate as Cf_i), or they may be "general" CFs (abbreviated as GCF). The Cf_i is specific to particular goods or services, while the GCF is an average of groups of goods and services. The group from which the average is calculated may be very broad (as in the case of the SCF), or it may be narrow (as in the case of a GCF for local transport services). Generally, the Cf_i, or the more narrowly defined GCF, is preferred over more broadly defined GCFs because the former should more accurately reflect actual resource flows.*

CFs may be either "centrally calculated", or they may be "project-related" CFs. The former may include both Cfi's and GCFs. Generally, project-related CFs are presumed more accurate than centrally calculated ones – particularly Cf_i; and we recommend that project-related Cfi be calculated for project cost or benefits exceeding 10 percent of the project total. CFs can be divided into "demand-price" CFs and "supply-price" CFs. The former are calculated when the primary project impact is manifested through an effect on the demand side of the market for the good, while the latter is calculated when the project impact is on the supply of the good. Much information regarding the government's taxation and sectoral policies is contained in CFs. We can gain valuable policy insights by simply comparing particular CFs with each other and with unity (1.0).

A2.3.1 SPECIFIC VERSUS GENERAL CONVERSION FACTORS

Gittinger (1982) provides guidance on calculating what economists call "specific conversion factors". However, the derivation of a second group of conversion factors call "general conversion factors" (sometimes also called "average conversion factors") is left to the Planning Office. General conversion factors are nothing more than weighted averages of particular groupings of specific conversion factors. The way the grouping is made depends upon the use to which the GCF is to be put. In general, the broadest of these groupings will take place in calculating some form of the standard conversion factor (SCF). Thus, the SCF is a form of general conversion factor.

General conversion factors (GCFs) have a number of uses in project economic analysis. The most prominent use is the conversion to border prices of project inputs or outputs that are too minor by them to warrant detailed analytical work. Examples would include local transportation services involved in moving a relatively minor imported project input from the port to the project gate. Rather than spending time to determine the mode of transport and finding the correct economic value for the transport, it may be wiser to just use an average conversion factor calculated for the modes of transport that historically have been involved in moving goods of that type. The modes that might be included for calculating this particular local transport GCF might include contract trucking services, rail services, and perhaps even rickshaw services.

In the following section we discuss some of these GCFs and their relationship to certain specific conversion factors. Specific conversion factors will be indicated by the letters Cf_i, where i refer to the item for which the specified conversion factor is being calculated – eg CF_{ul}, where ul refers to unskilled labour and CF_{ul} means "the specific conversion factor for unskilled labour". The term "conversion factor" will be indicated by the abbreviation CF; CFs may, of course, be either CF_i's or GCFs.

A2.3.2 DERIVING AND USING CFS

We have said previously that conversion factors are nothing more than the ratios of border values over financial values of the item whose economic value is being estimated. In economic analysis, when an item is "border priced" all of the transfer payments are deleted in the shadow pricing process before determining the border values. The transfer payments result from the domestic and the border distortions.

We have also said previously that, as a matter of convenience, CFs may be calculated for traded goods as well as for non-traded goods. In any event, conversion factors are really nothing more than a convenience for us – a convenience that can lead to errors in project analysis, if they are not calculated and used carefully.

Whether the CF being dealt with is for a traded or for a non-traded good, the CFs used in project economic analysis fall basically into two groups:

(a) *Project-related conversion factors.* These are calculated by the project appraisal team, where the item being border priced in a major item in the project cash flow (generally, more than 10 percent of project costs or project benefits).

(b) *Centrally calculated conversion factors.* These usually are provided by the Planning Officer, or by some other central institution, to be used in cases where the item being border priced is a minor item in the project cash flow. Generally, less than 10 percent of the project cost or project benefits.

In general, more specific CFs (eg those for rickshaw transport) is preferred to more aggregated CFs (eg those for domestic local transport). By the same token, project-related CFs that is calculated by the project analyst are preferable to centrally calculated CFs, except for CFs relating to so-called "national parameters" such as the SCF, the consumption conversion factor, and the discount rate. This is true, in particular, for specific conversion factors. Specific conversion factors that are centrally calculated will have two weaknesses compared to those calculated by the project analyst:

First, the centrally calculated Cfi's will be more aggregated, or more "average", in the following ways:

(a) The local transport component of the cost will have to be an average for all sites in the country and will not be project related; and
(b) The cost structure for the project inputs will reflect the average producer of that product in the country rather than that of the actual source of the input to the project.

Second, the centrally calculated Cf's are likely to be less current than those estimated by the appraisal team. They can be no more current than the data upon which they were based. Centrally calculated Cfi's tend to rely heavily upon secondary data which may have been collected for some other purpose, such as building input-output models, for instance.

These weaknesses of centrally calculated Cf_i's place trainers in project appraisal and managers of line agencies in a difficult position. On the one hand, non-economists need to understand and be able to use techniques of project economic analysis because in many cases they are the only people involved in planning locally financed agricultural projects, and because agriculturists usually understand the possibilities for substituting technical inputs and outputs better than do economists; therefore, they are usually better suited to reshape agricultural projects to improve their economic impact. On the other hand, it has long been realised that CFs that are correctly calculated by the project appraisal team are generally more accurate than comparable centrally calculated CFs (except the "national economic parameters").

Every trainer and every line agency manager should recognise this conflict and should keep in mind the compromises that are involved in teaching non-economists in the line agencies to carry out project economic analysis. Underlying the development of Gittinger (1982) was the recognition that, in a number of countries and agencies, project economic analysis will not be undertaken for locally financed agricultural projects if agriculturists are not taught techniques in project economic analysis and are not motivated to use them.

A2.3.3 FORMS OF GENERAL CONVERSION FACTORS

Standard Conversion Factor. The SCF is the broadest of the CFs that are discussed in this section. It should normally be calculated as a weighted average of the other CFs, with the weights calculated from marginal proportions that each good represents in the national production of the country. Because it is the broadest of the CFs, it should not be used except when there is no other CF available. There are two different ways of calculating the SCF: the trade data approach and the weighted average CF approach.

Consumption Conversion Factor. This too is a broad or aggregate CF, though not as broad as the SCF. It too is a weighted average CF, with the weights based on the average propensity to spend and on income elasticities of demand for the various goods and services represented in the consumption basket of the country. This GCF is used in converting non-traded consumption goods into border prices, where we do not have a Cf_i, or where the item is so minor in the project cash flow that calculating a Cf_i is not warranted.

Construction Conversion Factor. This is a GCF for use in border pricing general construction activity where it is not practical to break down the components and border price them separately. In deriving this GCF, the weights are usually based on the average expenditure patterns experienced in construction activities that are representative of project construction in the country. It would be useful if the Planning Officer would provide different construction conversion factors for different areas of the country. (See Ahmed (1984) for a numerical example).

Local Transport Conversion Factor. This is a GCF which converts to border prices the average cost of internal transport within the country. It is usually calculated by border pricing the traded inputs (eg vehicle costs, spare parts, and petrol, oil and lubrication) and using the most specific conversion factors that are available on the non-traded inputs (eg vehicle maintenance, labour for driving and loading/unloading, and overheads). The local transport conversion factor may be calculated as an average CF for all models of transport, or different versions may be developed based on different aggregations of modes. For example, a GCF may be calculated for water-borne transport in which barge transport and other forms are combined and averaged together; or a GCF may be calculated in which water-borne and surface transport are combined into one average GCF for transport.

If we know that the goods would move by water, then the CF that is calculated most specifically related to that mode will be the most accurate in removing the distortions that affect the price of that particular mode. For example, if we know that the goods will be moved by barge, then our preference for a CF would be in the following order:

(a) a Cf_i for barge transport;
(b) a GCF for water-borne transport;
(c) GCF for local transport; and
(d) the SCF.

(For an example of a derivation with a detailed cost breakdown of a supply-price conversion factor for transport services, see Anand (1975). Ahmed (1984) provides an example using input-output data.)

Electricity Conversion Factor. This GCF would be calculated based on the long-run incremental economic cost of supplying electric power for the kinds of projects likely to be included in the government's investment portfolio. When these GCFs are calculated by the World Bank for use by its staff, the calculation is greatly facilitated by the existence of a rational plan which describes expected future expansion of the electricity supply system.

In addition, several other GCFs may also be calculated, including: GCFs for manufactured goods that are used as inputs to production processes, civil works conversion factors for the kind of civil works involved in typical government projects, water supply and other public utilities which appear as costs in a large number of projects, and so forth. (See, for example, Page (1982) in addition to the derivations in Mashayekhi (1980) and Ahmed (1984) for the conversion factors of capital goods, intermediate goods, and wages.)

A2.3.4 CATEGORY OF SPECIFIC CONVERSION FACTORS

In Chapter 7 of Gittinger (1982), a "decision tree" is presented which categorises the major types of economic valuation issues that are expected to arise in the economic appraisal of agricultural projects.

We separate all project inputs and outputs into traded goods and services, and non-traded goods and services. This will provide us, initially, with four categories of items to be valued in the project economic analysis:

Traded goods and services:

1. Project outputs
2. Project inputs

Non-traded goods and services:

3. Project outputs
4. Project inputs

"Conversion factors for traded goods" (and services) are calculated by dividing the "Parity price" of each traded good by its respective financial price. The derivation of import and export parity prices is discussed in Gittinger (1982: 269-277). Conceptually, it is easy to understand the derivation of CFs for traded goods. However, it may be a bit more difficult in practice. Because there tends not to be as much confusion regarding the economic valuation of traded goods, we shall focus in this section on the non-traded goods.

The following are the major categories of non-traded goods for which we can derive economic values, or the CFs from which we can calculate those economic values:

Non-traded project outputs

(Demand-price conversion)

ANNEXURE 2

Non-traded project inputs

1. Non-reproducible inputs
   (a) Land (Demand-price conversion factor)
   (b) Labour (Demand-price conversion factor)

2. Reproducible inputs
   (c) Excess capacity exists in the industry that is producing the input (Supply price conversion factor)
   (d) No excess capacity exists in the industry that is producing the input

(i) Industry will add capacity to accommodate project demand (Supply-price conversion factor)
(ii) Industry will not add capacity to accommodate project demand (Demand-price conversion factor)

"Non-reproducible inputs" are those whose supply is presumably not directly related to economic phenomena. Land, for example, is assumed to be in fixed supply in absolute terms. Similarly, the absolute quantity of non-traded labour is presumably fixed at any point in time, though the "supply" of labour may adjust to wage increases by increasing the labour force participation rate in the short run. Obviously, such a definition is only useful as a heuristic device in understanding the supply constraints that may be expected to affect these inputs. In recent decades, the development of international trade in various categories of labour, have had a significant impact on the utility of this definition.

The utility of the "non-reproducible" definition is that it implies that the supply of those inputs is inelastic with respect to price. In other words, their total quantity cannot be augmented in response to a price increase. While this is not strictly true – especially for labour – nevertheless, it is useful to us in deciding what kind of conversion factor to calculate.

Analysts generally divide conversion factors for project inputs into two groups, based upon whether the supply of the input is expected to increase to accommodate an increase in demand imposed by the project. Non-traded inputs whose supply will expand to meet project demand will be dealt with by using "supply-price conversion factors". Non-traded inputs whose supply will not expand to meet project demand will be dealt with by using "demand-price conversion factors". For example, we might be appraising a project which will purchase from a local supplier several small diesel engines that are needed to power small, mobile milling equipment for the project. If the engines are the one-cylinder type ha are not found any more and would not be among the countries' traded goods, we would have to value these project inputs as non-traded inputs. Immediately, we encounter the question of whether the supply of the engines will expand in order to meet project demand; or will the supply not respond for some reason, forcing the project users to simply bid them away from other purchasers. The different ways of calculating supply-price and demand-price conversion factors in cases such as the one cited in this paragraph are discussed in the next section.

We can define the categories of non-traded goods for which supply price CFs will be calculated and those for which demand-price CFs will be calculated. These are shown in parentheses after each category of non-traded goods. We can see that, for the inputs, a distinction is made regarding the issue of whether production of the non-traded good will increase in order to supply the project. If it will increase, then the economic cost of the good will be calculated from the incremental inputs required to produce the incremental units needed to supply the project. This case, as we shall see, falls under the heading of a "supply-price conversion factor".

If the supply is not expected to increase, then it makes no sense to cost project inputs in terms of their incremental production cost, for here will be no incremental production of the item. Instead, the project input must be cost in terms of the impacts on the economy that are caused by taking the item away from its alternative use. This latter case falls under the heading of a "demand-price conversion factor". Gittinger (1982) speaks of valuing these inputs in terms of their opportunity costs, and that is just what the demand-price conversion factor for a project input is designed to do. His point is discussed further in the next section.

The way we deal with non-traded outputs will differ depending upon whether complete or partial border pricing is practiced. The partial border pricing approach discussed in Gittinger (1982) advises us to:

(a) Determine the demand price for the output; and
(b) Multiply that price by the SCF when using the SCF approach.

In applying complete border pricing in the foreign exchange numeraire, we should try to determine the traded goods for which the project's non-traded output would substitute in the market; and we should use the border prices of those goods in estimating the foreign exchange saved by producing the project's "non-traded" outputs. The ratio of the foreign exchange savings over the financial price of the non-traded output would be the demand price conversion factor for the non-traded output.

A2.4 SUPPLY-PRICE AND DEMAND-PRICE CONVERSION FACTORS

"Conversion factors for non-traded project inputs" fall into two groups, depending upon the extent to which supply of the input is able to expand to meet the increase in demand that is imposed by the project. The two groups are:

(a) Supply-price conversion factors; and
(b) Demand-price conversion factors.

The "supply price conversion factors" are used in cases in which the supply of the project input being border priced expands to meet the additional demand imposed by the project. Because supply expands, the incremental cost imposed on the economy by the use of this input by the project will be the cost of the incremental resources that are used in meeting the required supply expansion. Supply-price CFs are calculated only for project inputs.

The "demand-price conversion factors" are used in cases in which the supply of the project input will not expand to meet the additional demand imposed by the project. They are called demand-price CFs because the project inputs will have to be taken away from someone else's use, indicating that the costs will be imposed in the form of unmet demand borne by the alternative user of the input.

Demand-price CFs are relevant in cases in which supply cannot, or will not, increase to accommodate the project. The most prominent examples of inputs for which demand-price CFs are normally calculated are land and labour. (We say "normally" here because certain types of labour in certain countries are viewed increasingly as a traded input – whose supply to the economy can be increased by importing more foreign workers or by exporting fewer domestic workers – rather than being a non-traded input whose supply is fixed in the short run.)

"Specific conversion factors for project inputs" will be either a demand-price or a supply-price conversion factor. GCFs for project inputs, of course, will be an average of several Cfi's. In principle, that average may include a combination of Cf_i's, some of which are demand-price and some of which are supply-price Cf_i's. However, in practice, GCFs for project inputs will often consist of averages of a set of supply-price Cf_i's. This is because they will often be calculated from data (such as that for an input-output model) which relate inputs to outputs and which assume that output will expand to meet demand increases. In economist's jargon, such economic models normally assume that supply is "elastic".

"Demand-price CFs for non-traded project outputs" will also need to be calculated. These demand-price CFs will be derived from the ratio of the border price to the financial price, as with all CFs. If it is possible to find substitutes for the non-traded project output, then the border price in the ratio will be that of the traded good for which the project output will substitute, while the financial price in the ratio will be that of the project output. In Gittinger (1982), we are advised to use the SCF as the CF for non-traded project outputs. This approach is probably sufficient in most cases – in particular if the appraisal is being done by someone with limited understanding of economics, or if the output is a minor part (less than 10 percent) of profit benefits.

As discussed previously, the use of the SCF in such cases may be based upon either of the following assumptions:

The first assumption is that the items that are being substituted for by the project output have Cfi which are close to the SCF. This will be sufficient, if the item represents a small part of project costs, or of project benefits.

The second assumption is that the non-traded good for which the CF is being calculated will not have traded goods substitutes, and thus the border distortion adjustment is being made in terms of the distortion between traded and non-traded goods in general.

A2.4.1 AN EXAMPLE OF DEMAND-PRICE CONVERSION FACTOR

A "demand-price conversion factor" for a project input is calculated by comparing the financial value of that project input with its economic value, where the economic value is calculated in terms of the losses borne in the alternative use of that same input as a result of the input being transferred to project use. The losses borne by the alternative user of the input can be measured from the marginal value project

(MVP) of the input in its alternative use. Since the demand for an input is represented by the input's MVP function, the CFs derived in this way is termed demand-price CFs.

Let us look at unskilled labour as an example of the calculation of a demand-price CF for a project input. First we shall look at a case in which there is no domestic distortions to be dealt with. Then we shall look at a case in which both domestic and border distortions affect the price of unskilled labour. (See also Tower & Pursell, 1986).

The market for unskilled labour is usually competitive in rural areas, where wages are largely determined by competitive forces and are not controlled effectively by minimum wage laws, government employee wage structures, multinational wage practices, and other factors which tend to fragment urban wage structures. In such a case, domestic distortions affecting the price of unskilled labour may be minimal. The presence of regional and seasonal differences in wage rates and the presence of labour migration will usually imply competitive unskilled labour markets in rural areas.

The competitiveness of the market for unskilled labour implies that workers tend to be paid their MVP in domestic price terms. The MVP of labour measures the addition to the value of the product that is brought about by adding one more labour input at the margin of production. In competitive markets, workers will usually be paid wages that reflect the MVP of labour. This MVP will depend upon two things:

(a) The marginal physical product (MPP) of labour; and
(b) The price of the output that the labour is being used to produce.

The MPP is the amount that one more labourer adds to output in physical terms (eg in kilograms) at the margin.

The MVP of any input is estimated as follows:

$$MVP_i = MPP_i \times P_o \quad (A2.7)$$

where:

MVP_i = Marginal value product of the input;

MPP_i = Marginal physical product of the input; and

P_o = The price of the output being produced.

If the rural unskilled labour market is, in fact, a competitive market, then we would expect the MVP of labour to be roughly the same between crops on the same farm, as well as among different farms in the same labour market area. If the project that is being appraised is not so large as to greatly alter the demand for labour relative to the supply of labour, then the price of unskilled labour in rural areas should not change drastically as a result of the project. Under those circumstances, we may use the market wage rate as the estimate of the MVP of labour in the non-project alternative use of that labour. The market wage rate would be our estimate of the shadow wage rate (SWR).

$$SWR = MVP_{labour} \quad (A2.8)$$

Note that the SWR represents the opportunity cost of labour stated in domestic price terms. If we use border pricing, we need to state our SWR in border price terms. These are two ways to convert the SWR to border prices:

If we use the partial border pricing method, we simply multiply the SWR by the SCF.

$$BP_l = SWR \times SCF \quad (A2.9)$$

where:

BP_l = Border price of labour

If we use the complete border pricing method, we substitute for P_o in equation (A2.7), the border price equivalent of P_o in place of the financial price P_o. If the output that the labour would be used to produce in its non-project alternative employment were rice, then we would substitute the border price of rice for the financial price in the equation on the MVP of labour.

$$BP_l = MPP_l \times BP_o \quad (A2.10)$$

or, alternatively

$$BP_l - SWR \times BP_o/DP_o \quad (A2.11)$$

where:

BP_o = Border price of output; and

DP_o = Domestic price of output

Let us recall that in economics a "normal profit" is considered to be the opportunity cost of entrepreneurship. Thus, profit rates roughly equivalent to the opportunity cost of entrepreneurship would be included in the real cost of supplying the product. Profits in excess of the expected normal profit – called "pure" profits by economists and "excess" profits by politicians – may or may not represent "transfer payments" when it comes time to calculate supply-price conversion factors for project inputs.

The existence of pure profits among input suppliers should be assessed in terms of the expected duration of these profits. Are the pure profits simply short-run profits that exist because the industry is in the process of adjustment? Or are they long-run profits that are attributable to some aspect of market failure, such as imperfect competition? In the case of short-run profits some economists would argue that they are not in "excess", because that is the mechanism by which market draw additional investment into the production of that product. If the profit are long-run pure profits, then we may have found another case in which the project analysis identifies a need for a more compete policy analysis of the input-supplying sector.

Here again we illustrate our earlier point that the project appraisal team should be expected to learn a great deal about the effects that policies in other sectors of the economy have on the agricultural sector. Most economists would consider such long-run profits to represent transfer payments, and therefore would delete them from the column of real economic costs in calculating the supply-price conversion factors for inputs supplied by such industries. But we should keep in mind the point that if the item needs shadow pricing, its supply may also need to be analysed in terms of policy changes to deal with an existing aspect of market failure.

Let us return now to the issue of getting incremental cost data from accounting data. The cost breakdown in the preceding tables used a "quasi-income statement" format. The overheads that are allocated to the input being supplied to the project will be of two types:

(a) Direct overheads; and
(b) Indirect overheads

"Direct overheads" are that portion of the overhead costs of the company that can be directly attributed to the product that the project will use. "Indirect overheads" are that portion of the company's overhead costs that cannot be allocated among products. Economists consider any method of allocating indirect overheads among products to be arbitrary, for example, see Backer & Jacobsen (1964: 115-135).

In this illustration, we will use the complete border pricing approach. For example, let us say that we are estimating the conversion factor for unskilled labour (CF_{ul}) in Bangladesh, where rice production is indeed the likely alternative use for rural unskilled labour. The MVP of unskilled labour and the rural wage rate in Bangladesh would be heavily dependent upon the MPP of labour and the domestic price of rice. Bangladesh is a net importer of rice. For purposes of our calculation, let us assume that there is some minor distortion between the border and domestic prices of rice. Let us also say that the CIF price of rice in Bangladesh (converted to taka at the OER and ignoring, for the time being, the issue of local transport) is Tk 5,000/ton, while the domestic price of rice is Tk 5,500/ton.

Assume that MPP = 0.01 tons of rice produced per day,

Then: MVP = 0,01 x Tk 5500 = Tk55/day, and

SWR = Tk 55/day

The SWR of Tk 55/day is stated in domestic prices. We want to get the economic cost of unskilled labour stated in border prices, if we are using the border price level version of the numeraire (as our use of the term "conversion factor" implies). To do so, we revalue the rice in border price by taking its CIF price, and we recalculate the economic cost of unskilled labour as follows:

BVul = MPP x CIF

= 0.01 x Tk 5000 = Tk 50/day

where:

BVul = Border value of unskilled labour, and

CIF = the CIF price for rice

The border price for unskilled labour, then, would be Tk 50/day. To get the CF_{ul}, we would divide Tk 50 by the financial price of unskilled labour. In a competitive market such as the one we have discussed, the financial price would be Tk 55/day, giving us the CF_{ul}, as follows:

CFul = Tk 50/Tk 55 = 0.909

In the Bangladesh example, the conversion factor for unskilled labour (CF_{ul}) would be the same as the conversion factor for rice (CF_{rice}). This is true because there is no domestic distortion for unskilled rural labour, per se, in the case just cited. In this example, the only correction so far is for distortions which occur at the border and which occur indirectly through the impact on the domestic price of rice. Note that we could have used the CF to correct for the border distortion; but the use of such an aggregated CF would have involved correcting for the average distortion affecting all commodities that were weighted into the SCF calculation. If we know that it is the border distortion for rice specifically that is having the major impact on the domestic price of rural unskilled labour, then we will achieve a more accurate correction by using the CF_{rice} rather than the SCF.

What if the majority of rural unskilled labourers were not engaged in rice production and, thus, the wage rate was not primarily distorted by border distortion for rice? What if, in fact, rural unskilled labourers were producing a wide range of crop, each of which had its own specific set of distortions? In that case, we would need to substitute a GCF calculation for the "basket" of crops that they would actually be engaged in producing in the place of the CF_{rice}. The closest GCF that we have to that particular basket of production would be the best one to use. If we had one for "crop products", then that would probably be the best one. Or, if we had one for "agricultural outputs", that would be the second best one. If we had none of these, then the consumption conversion factor (CCF) would likely be our next best choice. Certainly, in a case like Bangladesh, where a large portion of total consumption expenditure is accounted for by food, it would be better that we use the CCF than the SCF in estimating CF_{ul}.

What if the rural labour market were not competitive for one reason or another? Then there would be a second element in the above calculation. That element would arise from the fact that the SWR and the financial price were different, ie. that there was a domestic distortion present, in addition to the border distortion, affecting the price of unskilled labour. In that case, we would not use the market wage as the estimate of the MVP of unskilled labour. We would have to undertake specific studies to determine the MPP or the MVP of unskilled labour, and we would use those data in calculating the shadow wage rate and the CF_{ul}. Our border priced economic cost of unskilled labour would still be calculated as MPP x CIF, but the CF_{ul} would be:

$$CF_{ul} = \frac{BV_{ul}}{\text{Min wage}} = \frac{\text{Tk } 50}{\text{Tk } 80} = 0.625$$

The difference between the previously calculated CF_{ul} of 0.909 and the just calculated CF_{ul} of 0.625 lies in the domestic distortion that is implied by the minimum wage law. Because of this distortion, the ratio of the SWR in domestic price terms (Tk 55) divided by the financial price of unskilled labour (Tk 80) equals 0.69. If we were using the SER approach to economic analysis (ie a domestic price level-denominated numeraire), then our shadow price factor would be 0.69.

However, we wish to use a numeraire denominated in border price (ie the SCF approach), so we must show the economic cost of unskilled labour in border price terms. We do so by multiplying the shadow price factor, which adjusts for the domestic distortion for labour, by the conversion factor for rice, which adjusts for the border distortion affecting unskilled labour, as follows:

$$CF_i = DDF \times BDF \qquad \text{(A2.12)}$$

where:

DDF = Domestic distortion factor; and

BDF = Border distortion factor

$$CF_{ul} = \frac{SWR}{\text{Min wage}} \times \frac{\text{Border price of rice}}{\text{Financial price of rice}}$$

$$CF_{ul} = \frac{550}{550} \times \frac{550}{800}$$

$$CF_{ul} = 0.69 \times 0.909 = 0.625$$

We can see that in using the complete border pricing approach, we shall always try to use a CF_i as the border distortion factor. The SCF would only be used when the project labourers who were being border priced were engaged in producing a wide range of goods and services – a range which was too wide to use a narrower CF. In the partial border pricing approach, in contrast, we could use the SCF because we did not expect that a relationship of any substance existed between the non-project use of labour and the availability of traded goods.

A2.4.2 CONVERSION FACTORS FOR TRADED LABOUR

In today's world, some labour may be valued as a "directly traded" project input. Bangladesh, Korea, the Philippines, and Yemen, for example, all have exported labour to the oil-producing countries of the Middle East at one time or another. Similarly, many African countries have imported skilled and managerial labour to assist in project management functions.

In appraising projects in the labour-exporting countries, any project labourer who would have worked abroad in the absence of the project may be treated as a diverted export; see Gittinger (1982: 253). The foreign exchange cost of a worker to the project would be the forgone foreign exchange repatriations, ie. the opportunity cost in foreign exchange terms of bringing the worker home to work on the project instead of allowing him or her to continue to work in the Middle East. The conversion factor, then, would be calculated by taking the ratio of the forgone foreign exchange divided by the actual financial wages to be paid.

For a project in one of the labour-importing countries, incremental labour imports would be treated as a traded input. The labour's economic cost in foreign exchange terms would be the sum of its foreign exchange repatriations, plus the border priced cost of the labour's subsistence in the country. The conversion factor, then, would be the ratio of this sum divided by the financial wages to be paid.

A2.4.3 AN EXAMPLE OF SUPPLY-PRICE CONVERSION FACTOR

We may envision three cases of calculating conversion factors for non-traded, reproducible project inputs:

(a) *Excess capacity in the input supplying industry.* In this case, we calculate a supply price CF, in which we consider overheads and profits to be "sunk" elements.

(b) *No excess capacity, but capacity expands*. There is no excess capacity in the supplying industry, but the suppliers agree to increase production capacity to meet the project's demand. In this case, we calculate a supply-price conversion factor in which we consider overheads and profits to represent incremental costs of supplying the input.

(c) *No excess capacity and supply does not increase.* There is no excess capacity in the supplying industry, and the suppliers will not increase production capacity to meet the project's demand. In this case, the project's input will come from the goods that would otherwise have gone to other users; thus, we calculate a demand-price conversion factor for the project input, similar to the CFs that would be calculated in the normal case of land or labour, which are usually considered to be "non-producible" inputs.

In the case of project inputs that are not traded and are produced locally under conditions of excess capacity, we need to calculate a supply-price conversion factor. To calculate this factor, we must convert the financial cost to economic costs, via the border pricing approach by:

(a) Deleting taxes and subsidies;
(b) Border pricing the incremental traded inputs used in producing the project's input; and

Repeating steps (a) and (b) until, in theory, all the incremental non-traded inputs that are used in producing the project's input are reduced to a combination of directly and indirectly traded inputs, land, and labour.

The ratio of the resulting economic value divided by the financial value for the input will be the supply-price conversion factor for this input.

Each specific conversion factor represents the product of a "tracing" exercise, in which each non-traded input is broken down into its inputs – round after round, until the remaining non-traded factors become insignificant. In practice, the point of insignificance is usually defined to occur when the resulting item becomes less than 10 percent of total capital costs (if it is a capital cost item), or of operating costs (if it is an operating cost item),

ANNEXURE 2

The following paragraphs illustrate the methods that are often used in calculating supply-price conversion factors. We use the example of a locally made and non-traded one-cylinder engine that is to be used as a project input. In calculating supply-price conversion factors, a distinction is sometimes made between suppliers having excess capacity and suppliers having no excess capacity. Both cases are illustrated below.

In calculating a supply-price conversion factor where the supplying firm (or sector) will have excess capacity sufficient to supply the project input, the "overhead and profits" element of the product cost structure is treated as "sunk" in the short run and is not included in the economic cost of supplying the input. Table 2 illustrates calculation of a supply-price conversion factor for engines to be used as project inputs in the case in which excess capacity exists. The excess capacity is expected to last during the period in which the project will be purchasing engines and is expected to be sufficient for the project demand to be met without fully using existing capacity.

Because there is excess capacity, the suppliers will not have to expand to meet the project demand. Thus, the fixed elements of production cost will not be "incremental". Since in economic analysis, we only include incremental costs, the fixed elements will be considered to be "sunk" and will not be included in the calculation of economic costs of the engine. This is indicated by the use of a CF of zero for the "overheads and profits" element of costs in Table A2.1

Table A2.1: Cost Breakdown: Locally Made Engine *(Excess capacity in engine industry)*

	Financial Cost (R)	Conversion Factor	Economic Cost (R)
Raw materials (RM)			
Imported:			
CIF	300	1	300
Duties	60	0	0
Local transport	40	0.7	30
Local RM	150	0.6	90
Unskilled labour	200	0.4	80
Skilled labour	50	0.8	40
Misc. materials	20	0.8	16
Utilities	20	0.9	18
Other costs	35	0.8	26
Taxes	100	0	0
Overheads and profits	125	0	0
Total cost	1000		600
CF for motor = R600/R1000 = 0.60			

In the case of project inputs that are not traded and are produced locally under conditions of no excess capacity and suppliers expand to meet the project demand, the supply-price conversion factor is calculated exactly the same as the one calculated in the previous paragraph, but with one change. In the present case, the fixed costs are not treated as "sunk costs". Rather, they are also considered incremental costs, since the input-supplying firm will be to expand its capacity in order to supply the inputs that will be demanded by the project.

If you look closely, you will see that the difference between the economic prices and the financial prices will be determined by direct and indirect "transfer payments". In Table A2.2 (no excess capacity case), all of the transfers involved government transfers, ie. the involved taxes and subsidies, and thus were induced by government policies. In the excess capacity case, transfers also went to the firm that was supply the inputs to the project. These latter transfers had to be due to monopoly elements in the input-supplying industry in the absence of monopoly elements, competition between suppliers would have forced the supplying firm to reduce the price.

In the face of excess capacity, competition should have forced the price down to a level just sufficient to cover the variable costs. In other words, if the input-supplying industry had been competitive, the financial price actually paid for the project input (one engine) should have been R875, rather than R1000. The difference between R1000 and R875 in this case was defined as "excess profit". (In the context of shadow pricing, the excess profit would be called a "transfer payment". Economists use the term "transfer payment" and "economic rent" when speaking of payments for which there are no real resource costs.) Then in the latter calculation in which the CF for motors was calculated to be .70, we must have been assuming that there were no excess profits; otherwise, we would have had to adjust the R125 of "overheads and profits" downward to reflect the "normal profit". Let us recall that in economic analysis a normal profit (the opportunity cost of capital provides a reasonable estimate of what the normal profit should be) is assumed to be part of the opportunity cost of management and entrepreneurship.

Table A2.2: Cost Breakdown: Locally Made Engine ***(No excess capacity in engine industry)***

	Financial Cost (R)	Conversion factor	Economic cost (R)
Raw materials (RM)			
Imported:			
CIF	300	1.0	300
Duties	60	0	0
Local transport	40	0.7	30
Local RM	150	0.6	90
Unskilled labour	200	0.4	80
Skilled labour	50	0.8	40
Misc. materials	20	0.8	16
Utilities	20	0.9	18
Other costs	35	0.8	26
Taxes	100	0	0
Overheads and profits	125	0.8	100
Total cost	1000		700
CF for motor = R700/R1000 = 0.70			

In our supply-price conversion factor calculations, when we included overheads and profits in the incremental costs, we used a conversion factor for them of 0.8. In that example, we were assuming a standard conversion factor of 0.8. Let us recall that we said that the specific conversion factor that we used in making the calculations represented the product of having traced that particular input round after round until we had traced all of its inputs back to border prices (ie to foreign exchange). For those items that are so small as to not warrant a detailed tracing, we may use average conversion factors, such as the SCF, which is the most aggregated and averaged of all the conversion factors. This is understandable for the overheads. But, what about for the profits element?

The 'normal' profit represents a cost in the sense that the "entrepreneur" (or the owner) would have applied his entrepreneurship elsewhere and would have earned a comparable profit in the forgone activity. The profit would have related to the production of some other product that society would have consumed instead and that alternative product had a financial price; it also had a border price. The ratio of those two would have been its CF. Since we did not know what that product would have been, we simply used the average of all the CFs in the country, ie. the SC. Here is where we might find it useful to differentiate between two versions of the SCF: one calculated from the total goods and services *produced* in the country. The former would be the appropriate version for use in this application.

A2.5 ACCOUNTING ISSUES IN CALCULATING SUPPLY-PRICE CFS

The format of cost data for the engines, used in Tables A2.1 and A2.2 is laid out to account for two competing considerations:

(a) To obtain incremental cost information in a cash flow format; and
(b) To develop cost information for purposes of profit-and-loss accounting.

This format of the tables could help us conduct interviews to develop the supply-price conversion factors for major project inputs in a way that would accommodate both of these considerations.

An important point to note in preparing for the interview is that firms will be willing to disclose their actual profit margin on the product being supplied to the project. Thus, to ensure that the interviewee will provide the cost data, we may wish to lump together "overheads and profits" in one line in the table. This will allow the company to argue that all of his items are "overheads" and that prices are low. For purposes of calculating supply-price conversion factors there is no need to know the profit margin anyway.

The practical problem that project analysts, or the researcher have in developing the models from which CFs might be calculated is the same as that faced by regulatory commissions and agencies. To some extent, we are at the mercy of the company supplying the cost data. If the company's financial manager chooses to allocate a large portion of indirect overheads to that product, we will find it extremely difficult to go back and recalculate the cost accounts. This problem becomes more acute if the company manufactures a large number of products.

While cost allocation presents a difficulty in calculating supply-price conversion factors, the real issue is "incrementality". Will the demand posed by the project cause an element of cost of increase? That is the issue. Of course, it is generally easier to answer that question for direct costs than it is for indirect costs; and it is clearer in the case of truly variable costs (as opposed to fixed costs or "semi-fixed" costs – such as insurance premiums, for example). We could consult an engineer who knows that production process well and a cost accountant who knows the sector, but in the end it will be our own common sense that we will have to depend upon to fill the table with cost data that represent the incremental impacts caused by the demand posed by the project.

A2.6 INTERPRETING CONVERSION FACTORS

Using CFs to Interpret Sector Policies. We have said previously that conversion factors are used to convert a project's financial prices to economic prices in "border price" terms. Because they are applied to the prices used in the project financial cash flow, the value of the CF can be used to compare financial prices to economic values, and thus can be interpreted to yield information regarding government policies affecting those prices. Because of their potential use in making quick judgements on pricing policies, it will be helpful to understand certain generalisations that can be made by comparing the CF for an item with the SCF and with unity.

Cfs and Unity. In general, the closer a CF is to unity the smaller are the net distortions of the price for the item. We talk about "net distortions", because there may be more than one distortion affecting the price of an item. Some distortions may increase the price, while at the same time other distortions operating on that same item may have the effect of decreasing its financial price. Where the CF = 1, the border price and the financial price for the good are the same. The further the CF is from 1, the greater are the net distortions.

The net distortion for a particular border priced item is a combination of all the domestic distortions and all of the border distortions that affect the item. The net distortions may be dominated by either domestic or border distortions, or the net distortions for a particular item may be equally affected by each of these two types of distortion.

CFs Above and Below Unity. If the CF for any good exceeds 1, then the border price exceeds the financial price of the item. In this case, the net effect of the distortions in the economy would be to reduce the financial price of the item relative to comparable international prices. Some analysts choose to say that such an item is "subsidised" in local markets.

CFs for Exported Goods. If the good in question is an exported good, then the domestic price might be lower as a result of a tax on the exports of the good. In equilibrium, the local price of the exported good will be determined by the FOB price and the export tax on the good, as follows:

Local price = FOB – export tax

In contrast, an export subsidy would raise the local price of a good relative to its border price and would make its CF less than 1:

Local price = FOB + export subsidy

CFs for Imported Goods. For an imported good, a CF less than 1 implies that net taxes between the border and the final market for the good tend to increase its financial price over its border price, as follows:

Local price = CIF + import tax

CFs for Non-traded Goods. For a non-traded good, a CF greater than unity, ie. the economic price exceeds the financial price indicates that there are net distortions in the economy which reduce that item's financial price below its border price. This would be the case, for example, if there were subsidies on the input used in producing the item. Generally, we expect the CF for a non-traded good to be less than unity, since the net effect of a developing country's trade policy is usually to "overvalued" local currency. (Actually, it is more correct to say that the trade policy is part of a set of policies which allow the country to maintain an overvalued currency.)

The trade policies that maintain an overvalued local currency tend to have a net effect of raising the domestic prices of traded goods. Since traded goods will be used as inputs in producing non-traded goods, the border distortions that occur through the trade policies will also tend to increase the prices of non-traded goods relative to border prices.

CFs for Traded Goods. Import tariffs and export subsidies are often used to support overvalued local currencies. As mentioned before, these two policies tend to increase the local price of traded goods. However, an export tax does the opposite: it makes it more difficult to maintain an overvalued local currency. In fact, a preponderance of export taxes could lead to an undervalued local currency, as would a preponderance of import subsidies – a policy, incidentally, which was related to a slightly undervalued Saudi rial in the mid 1970's.

CFs in Developing Countries. We generally find that in developing countries a majority of non-traded goods must have their financial prices reduced to get them to the border price level. Thus, we normally expect non-traded goods to have CFs less than unity. We expect this, but we find that some of these goods will have CFs greater than unity, while the majority of goods presumably will have CF less than unity. The average of these CFs, however, will usually be less than unity, indicating the tendency for the trade policy to have the net effect of increasing domestic prices relative to border prices. This net effect would be reflected if we calculated an average for all the CFs. That is what the SCF does.

In practice, we find that SCFs for developing countries tend to range between 0.75 and 0.9. However, a particular country may have a SCF of 0.82; and it may have Cf_i ranging between 0.2 and 5.0, or even wider

A2.7 FORECASTING EXCHANGE RATES, IN PRACTICE: THE PURCHASING POWER PARITY CALCULATION

***Summary**. Forecasting project cash flows requires making three exchange rate forecasts: the nominal official exchange rate (OER), the real OER, and the shadow rate (SER). These forecasts may be made either explicitly or implicitly. A multitude of assumptions may be made in making the forecasts. The most commonly used assumption involves the purchasing power parity adjustment, which presumes that the nominal exchange rate will adjust according to the rate of domestic inflation in relation to foreign inflation, while the real exchange rate remains the same. These conditions are shown to hold, so long as commercial and financial policies are ignored, or are left unchanged.*

The model may be adjusted by considering changes in the weighted average tariff rate (WATR), which would affect the relationship between he SER and OER. When the WATR is allowed to change, the real SER may stay the same, while the real OER adjusts according to the change in the WATR. Forecasting this latter set of relationships becomes important in two environments. The first is an environment in which worsening domestic inflation leads to changes in commercial and financial policy. The second is structural adjustment environment, in which commercial and financial policy changes are planned as part of the adjustment.

Forecasting exchange rates requires much more economic understanding – and luck – than can be delivered in this volume. However, we implicitly forecast exchange rates every time we apply a project. In fact, sometimes we implicitly make forecasts of future exchange rates that would surprise us, if we realised what our forecasts implied.

Three Exchange Rate Forecasts. Project planning requires forecasts of three exchange rates:

(a) The nominal official exchange rate (OER), which is needed in making the project financing plan;
(b) The real OER, which is needed in making the project financial cash flow in constant prices; and
(c) The shadow exchange rate (SER), which is needed in forecasting the OER and in conducting the project economic analysis.

(An alternative to SER is the standard conversion factor, abbreviate as SCF.)

Implicit versus Explicit Forecasts of Exchange Rates. The project analyst is not necessarily the one who must make these forecasts; but, it is a fact of life that someone must. If the forecast is not made explicitly, then it will be implicit in the calculations made. One way of making these forecasts is to use the "purchasing power parity" assumption (Lindert (1986). We show the calculation using this assumption because of an important point: if the exchange rate does not change according to the purchasing power parity theorem, then we would expect that the SCF and other conversion factors would have to change during the life of the project.

The normal approach involves an assumption of constant conversion factors; it also involves the assumption of a constant, real official exchange rate. These assumptions are consistent with purchasing power adjustments in the nominal official exchange rate. However, these assumptions may not be consistent with commercial and financial policy reforms scheduled under a World Bank's structural adjustment loan, or an International Monetary Fund's extended fund facility, or some other agreement. In the case of projects implemented during ongoing structural reform, year-to-year real OER changes and changes in the country's conversion factors should be expected.

The Purchasing Power Parity Assumption. "Purchasing power parity" (PPP) implies that the exchange rate will adjust to maintain "parity" in the purchasing power of local and foreign currencies, when the rate of inflation in the home country is different from the rate of inflation among the country's major trading partners. For example, let us assume that local inflation is expected to occur at a rate of 10 percent per year over the next five years, while inflation in the country's trading partners is expected to average only 5 per cent per year. The most direct way that parity in purchasing power can be maintained between the two currencies is for the local currency to depreciate at the following annual rate:

$$\text{Rate of depreciation} = \frac{(1+0.10)}{(1+0.05)} - 1$$

$$= 4.76 \text{ percent per year}$$

If the OER were R10 = $1 at the beginning of the five year period, the OER would be expected to change as indicated in Table A2.3.

Table A2.3: Forecast of Nominal Exchange Rate Using Purchasing Power Parity Calculation

Year	OER at beginning of year R/$	OER at end of year R/$
1	10.00	10.48
2	10.48	10.98
3	10.98	11.50
4	11.50	12.05
5	12.05	12.62

Note: We assume domestic inflation at 10 percent per year and foreign inflation at 5 percent per year.

PPP without Trade Barriers. The calculation in Table 4 implicitly assumes that there are no trade or exchange barriers. Among other things, this assumption implies that the SER and OER are the same. We have said nothing of the "real" exchange rate in relation to the "nominal" exchange rate. Clearly, what was calculated in Table A2.3 was the nominal exchange rate (again making the simplifying assumption that there are no trade and balance of payments distortions, which means that the SER and OER will continue to be the same).

Nominal and Real Exchange Rates. The nominal exchange rate after one year has devalued to R10.48 = $1 in Table A2.3. Thus, it now takes R10.48 to import a good costing $1 at our border. If we define "real" to mean constant prices (with a base period set at the beginning of year one), then to put the current rupee price of one dollar into base period rupees, we should divide R10.48 by one the local inflation rate as follows:

$$\frac{\text{Nominal R10.48}}{1.10} = \text{Real R9.524}$$

From this calculation, we can see that the real price of a dollar in foreign currency has decreased during the year. However, because inflation in the foreign country has occurred at a rate of 5 percent during the past year, the foreign good that we could have bought years ago for $1 in foreign exchange now costs $1.05 in foreign exchange. What implication does that fact have for our real exchange rate calculation?

Since we are working in real terms, we are interested in the exchange rate between foreign and local goods. In currency terms, that means that we will need an additional 5 percent in local currency to pay for the inflation in the dollar price of the foreign good that has occurred during the year. Let us multiply, then, the real rupees by the actual number of dollars required to get the real rate of exchange between local and foreign goods after one year – where “real” is defined in terms of a base period, such as he beginning of year one:

Real R9.524 x 1.05 = R10

Thus, the “real” exchange rate is still R10 = $1. We can see from Table A2.4 that this will be the case for each of the five years for which we have forecast the nominal OER.

Table A2.4: Forecast of Real Exchange Rate Using Purchasing Power Parity Calculation

1	2	3	4	5	6
Year	Nominal OER at end of year R/$	Local price index at end of year	Foreign price index at end of year	Ratio of Price indexes	Real OER at end of year R/$
1	10.48	110.00	105.00	1.048	10.00
2	10.98	121.00	110.25	1.098	10.00
3	11.50	133.10	115.76	1.150	10.00
4	12.05	146.41	121.55	1.205	10.00
5	12.62	161.05	127.62	1.262	10.00

Note: We assume domestic inflation at 10 percent per year and foreign inflation at 5 percent per year.

The result in Column 6 can be obtained by diving Column 2 by Column 5.

From Table A2.4 we see what the application of PPP theory indicate about the nominal exchange rate, ie. that the nominal exchange rate will adjust in the face of differing domestic and foreign inflation rates so as to maintain the same real exchange rate over time, other things being equal.

Note that we normally conduct investment analysis using constant prices and that a preponderance of appraisals assumes a constant exchange rate during the life of the investment. By using constant price as the typical practice, we implicitly assume that the nominal exchange rate will devalue each year. We know the rates at which the nominal exchange rate will devalue. It will devalue by the ratio of one plus the respective inflation rates at home and abroad.

The preceding point regarding the implicit assumption of a devaluing exchange rate leads us to the politically sensitive issue of prices, such as the exchange rate. It is often possible to use “realistic” price forecasts, even for politically sensitive prices, without having to advertise their use and without incurring the wrath of the political hierarchy. These forecasts can be used implicitly in the worksheets without presenting them explicitly in the published project reports. Even sophisticated readers of the report will need the help of the report preparer to trace their way back to the price forecasts which underlay the final numbers.

PPP Adjustment with Trade Barriers. Let us move to the case in which there are trade and balance of payments barriers such that the SER and OER are not the same. We know that a weighted average tariff rate (WATR) of 25 percent would allow the OER to differ from the SER used in project appraisal by a factor of 1:1.25. Let us assume that the only border distortion affecting the prices of goods and services occurs in the form of tariffs and subsidies (all of which are accounted for in the WAR calculation). Let us also assume that there is no capital flight and that the demand and supply of foreign exchange is totally related to trade. This will allow us to work for the moment with only one SER.

If the WATR is 25 percent, then our SER used in project appraisal would be related to the OER as follows:

SER = OER x (1 + WATR)

OER = R10/$1

Therefore:

SER = R10/$1) x (1 + 0.25)

SER = R12.5/$1

In forecasting the nominal and real OERs, we would first forecast the SER, as was done in Tables A2.5 and A2.6. We then would have to forecast the WATR to determine the changes in the OER.

PPP and the SER. In the real world, it is the SER that moves according to the ratios of domestic and foreign inflation. The OER is then related to the trade (and payments) policies that separate the SER and OER. Assuming that the WATR calculation has captured all of those effects, we estimate the OER by dividing the forecast SER by one plus the forecast WATR, as indicated in footnote (a) to Table A2.5. We could have forecast the nominal OER directly from the ratio of the inflation rates, but, to do so would have assumed that the WATR was unchanged during the five year period over which the OER was being forecast.

Table A2.5: Forecast of SER and Nominal OER: Purchasing Power Parity Calculation

1	2	3	4	5
Year	Ratio of domestic over foreign price indexes	Nominal SER at beginning of year R/$	Weighted average tariff rate at beginning of year	Nominal OER at end of year R/$
1	1.048	12.50	0.25	10.00
2	1.098	13.72	0.25	10.98
3	1.150	14.37	0.25	11.50
4	1.205	15.06	0.25	12.05
5	1.262	15.77	0.25	12.62

Note: We assume a domestic inflation at 10 percent per year and foreign inflation at 5 percent per year. Column 5 = Column 3 divided by one plus Column 4

Because the SCF is derived from the WATR, we can say that the forecast nominal OER is derived from the forecast SER and the forecast SCF. Recall that the SCF is related to the WATR as follows:

$$SCF = \frac{1}{1 + WATR}$$

If the WATR is 0.25, as in Table A2.5, then the SCF is 0.80. Thus, the SCF has been forecast to remain constant.

Now let us see what would happen to the OER if the government were to change the trade policy during the five year forecast period. Table A2.6 recalculates Table A2.5 by using a different WATR assumption.

The WATR, the SCF and OER Adjustments. We can see the impacts of the changes in trade policy. First, the increase in the average tariff and subsidy rate (WATR), from 25 percent in year 2 to 33 percent in year 3, causes the SCF to decrease from 0,80 to 0.75. Second, the change in trade policy causes the nominal OER to decrease, because the change in tariff rate overwhelms the effect of the continued high domestic inflation compared to foreign inflation. We can see the effect of the WATR change by comparing the entries in Column 6 of Table A2.6 with their counterparts in Column 5 of Table A2.5.

Table A2.6: Forecast of SER and Nominal OER: Purchasing Power Parity Calculation

1	2	3	4	5	6
Year	Ratio of domestic over foreign price indexes	Nominal SER at beginning of year R/$	Weighted average Tariff rate at beginning of year	SCF	Nominal OER at beginning of year R/$
1	1.048	12.50	0.25	0.80	10.00
2	1.098	13.72	0.25	0.80	10.98
3	1.150	14.37	0.25	0.75	10.81
4	1.205	15.06	0.25	0.75	11.32
5	1.262	15.77	0.25	0.75	11.86

Note: We assume domestic inflation at 10 percent per year and foreign inflation at 5 percent per year.

Column 6 = Column 3 divided by one plus Column 4

= Column 3 multiplied by Column 5

Note that if the SCF changes, it does so because of policy change that will effect the ratio of domestic prices to border price of one more goods or services. Thus, the change in SCF normally implies a change in specific conversion factors also. That means a change in relative prices in occurring in the economy.

How realistic is it to expect a change in the SCF? Given the change in the nominal OER that are shown in Table A2.6, trade policy changes might well be expected to occur, either as the cause of he changes in the OER, or in reaction to the factors that are causing the OER to change.

Forecasting changes in these commercial and financial policies is difficult and is seldom done in the context of project appraisal. There are exceptions to this generalisation. For example, the Korea Economic Planning Board in the late 1970s made forecasts of the SCF that were based on the government's stated policy of rationalisation in the country's tariff and subsidy system. Because these forecasts are difficult to make and, because such forecasts are feared for their potential to destabilise the economy, they usually are not made in the context of project planning. Instead, certain standard assumptions tend to be made, which include:

(a) The real OER stays constant over the life of the project;
(b) Consistent with (a), the nominal OER makes purchasing power parity adjustments based on the difference between domestic and foreign inflation rates; and
(c) No major changes in domestic economic policy, or in trade policy, will be undertaken; thus, border and domestic distortions are expected to remain unchanged; and specific and average conversion factors – including the SCF – will remain unchanged during the life of the project.

These three assumptions are often made implicitly, without the analyst realising the implications of the method of calculation that is being applied. Usually these assumptions are made for one or more of the following three reasons:

(a) These assumptions greatly simplify the calculations;
(b) The analyst often will have no basis for making any other assumptions; and
(c) Political factors and the fear of destabilising financial and foreign exchange markets may prohibit the analyst from using any other assumptions than the ones cited earlier.

Standard PPP Assumptions and the SAL environment. The "standard" three assumptions cited in the preceding paragraph may appear to be unrealistic when the project that is being appraised is taking place within a "structural adjustment" environment. The structural adjustment program may change many of the economic parameters the project assumes to be constant. Indeed, the particular project that is being appraised may well be part of a set of interventions designed to bring about structural reform and change in prevailing price relationships. In that case, we have the classic problem that relates to planning and appraising individual projects in a general equilibrium context.

Politics of Forecasting Inflation and Exchange Rates. The forecast of the domestic inflation rate may pose more of a problem than the forecast of the foreign inflation rate. Government forecast of domestic inflation may be overly optimistic. Forecasts by external aid agencies may reflect the same bias, for a number of reasons – including the desire not to offend the host government. Because the exchange rate forecasts have links with the various project accounts it is important that the analyst work with a reasonable estimate of the expected inflation rates. Thus, the analyst may have to work with an "unofficial" estimate and hide that forecast behind the table that are presented in the reports. Likewise, he or she may have to also hide the forecast nominal OER behind the main tables and to present in the text only those tables that show the real OER.

But how do we get the estimate of the actual domestic inflation rate. In most countries, it is not all that difficult to get – unofficially – the estimate of actual inflation. We may just have to talk "off the record" to economists and officials in the agencies responsible for making such forecasts. They usually can tell us the approximate real inflation rate – if they trust us not to attribute the estimate to them, or to publish the estimate anywhere.

Information on Forecasts of International inflation Rates. The forecast of foreign inflation can be obtained from the World Bank's "price forecasts for major primary commodities", which is mentioned at various points in Gittinger (1982). If there is a World Bank field office in the country, the resident staff of he Bank could be asked what international inflation rates are being used by the Bank for its own analyses. The World Bank staff refer to this rate as the "MUV" which stands for the "manufacturer'' unit value index" The index relates to the kinds of goods and services that are used in World Bank assisted projects, and is based on expected inflation rates in the industrialised countries that are members of the OECD. The MUV is useful for estimating price contingencies. However, it is less useful as a measure of general inflation among a country'' trading partners. First, the MUV is calculated for a group of OECD countries, which might not be representative of our country's trading partners. Second, the MUV represents only a small number of selected categories of traded goods. Other sources of information include bilateral aid agencies, such as USAID, or multilateral organisations, such as the UNDP, the FAO and UNIDO; or the regional development banks, such as the Asian Development Bank, African Development Bank, Inter-American Development Bank, and others.

ANNEX 3: MANAGEMENT QUESTION SETS FOR ASSESSMENT

Management Area 1: Assessing Context and Organizational Responsiveness					
Rationale: Factors in an organisation's external environment (e.g. changing producer and industry needs, government policies, market conditions, partners, and competitors) will critically affect an organisation's performance. Any research organisation needs to regularly assess its context in order to plan and respond effectively to challenges and opportunities, and to produce outputs that are relevant and useful. This assessment will enable the organisation to change its strategies, programs, and priorities.					
Questions[18]	**Score**				**Evidence / Comments**[19]
1. To what extent are relevant agricultural sector documents (e.g. strategy and policy) consulted?	0	1	2	3	
2. To what extent are development goals (e.g. natural resource sustainability, poverty alleviation, and food security) taken into consideration?					
3. To what extent is your organisation considering the effects of government policies (e.g. market, price, and subsidy policies) on producers and other users?					
4. To what extent are stakeholder needs analysed?					
5. To what extent are overall government funding and disbursement levels for research analysed?					
6. To what extent are donor policies and country strategies analysed?					
7. To what extent are alternative possibilities for funding (e.g. contracts) analysed?					
8. How frequently are context factors, threats, and opportunities (including those represented by competitors) examined?					
9. To what extent are the roles and responsibilities of other research and transfer actors (public and private) considered and addressed?					
10. To what extent are the results of the context analysis disseminated and used in the organisation?					

Management Area 2: Planning Organisational Strategy					
Rationale: The external environment of research organisations is dynamic, causing changes in stakeholder conditions and needs. It is important for an organisation to periodically review and adjust its directions and goals, to reflect these changes. These adjustments in turn may require significant strategic actions, such as changes in mandate, focus and programs, organisational structure, and management mechanisms. Strategic planning, defined by Bryson (1995) as "a disciplined effort to produce fundamental decisions and actions that shape and guide what an organisation is, what it does, and why it does it," provides a means of repositioning the organisation in its environment, and of responding to challenges and opportunities.					
Questions	**Score**				**Evidence / Comments**
1. To what extent are context changes examined when defining organisational goals?	0	1	2	3	
2. To what extent are government and donor agricultural research policies and strategies used to establish goals and guide planning for the organisation?					
3. To what extent is the organisation's mandate referred to when defining organisational responsibilities and strategies?					
4. How often does the organisation undertake strategic planning?					
5. To what extent are strategic plans used by the organisation?					
6. To what extent are strategic priorities established for coverage of geographic areas, agroecological sones, producer groups, or partner needs?					
7. To what extent are structure and organisation adjusted because of changes in strategy?					
8. To what extent are operational plans derived from the strategy?					
9. To what extent are various categories of staff involved in strategic planning?					
10. To what extent are stakeholders and users represented in strategic planning?					
Constraint statements	**Level of urgency**				**Evidence / Comments**

[18] The set of questions needs to be reviewed and adjusted to the circumstances of individual organizations.

[19] It is good practice to provide explanatory notes on interpretations of questions and constraints by the assessment team.

ANNEXURE 3

Management Area 3: Defining Program Objectives and Priorities					
Rationale: *Program* can be defined as "an organised set of research projects, activities or experiments that are oriented towards the attainment of specific objectives. A program is not time bound, as projects are, and programs are higher in the research hierarchy than projects" (Gijsbers et al 2000). *Program objectives* should be consistent with organisational strategies and translated into feasible priorities that reflect user needs and development goals.					
Questions	**Score**				**Evidence / Comments**
1. How effective are the procedures for selecting program priorities (e.g. commodity and noncommodity priorities)?	0	1	2	3	
2. To what extent do priorities reflect national development goals?					
3. To what extent do staff of the organisation participate in program planning and priority setting?					
4. To what extent are constraint analysis and user surveys conducted and used to identify program objectives and priorities?					
5. How effectively are producer and other user constraints addressed during program planning?					
6. To what extent do producers participate in surveys, constraint analysis, and field research activities that provide information for program planning?					
7. To what extent is feedback from producers/users effectively used in program planning?					
8. To what extent are users, extension, and other stakeholders represented on the organisation's planning and review committees?					
9. To what extent do research programs reflect region-specific needs and priorities?					
10. To what extent are socioeconomic factors that affect adoption of research outputs (e.g. marketing conditions, prices, etc.) considered when establishing the research agenda?					

Management Area 4: Planning Research Projects					
Rationale: A project is a set of activities designed to achieve specific objectives within a specified period of time. A research project is composed of interrelated research activities or experiments that share a rationale, objectives, plan or action, schedule for completion, budget, inputs, outputs, and intended beneficiaries. Research projects are the buildings blocks of the program. For an organisation to achieve its objectives, projects need to be well planned in terms of their expected outputs, activities, and input requirements.					
Questions	**Score**				**Evidence / Comments**
1. Has a program framework for component projects been established that provides guidance for researchers during project planning?	0	1	2	3	
2. To what extent is there a formal process (including preparation, review, and approval) used for planning research projects/activities?					
3. To what extent are comprehensive budget preparation guidelines, norms, and standards applied?					
4. How effective is the project-planning procedure for identifying resource inputs (e.g., staff, supplies, etc.), outputs and indicators of success?					
5. To what extent are project priority-setting procedures used to determine the relative importance of research activities?					
6. To what extent are organisational plans (e.g. medium-term plan, corporate plan, strategy etc.) used to guide project design?					
7. To what extent are production constraints considered during research project or activity planning?					
8. To what extent are researchers responsible for preparing project proposals and budgets?					
9. To what extent are previous research results/data used by researchers to avoid duplication and ensure new initiatives?					
10. How effectively are project-planning procedures integrated with government and donor budget cycles?					

ANNEXURE 3

Management Area 5: Managing Projects and Maintaining Research Quality					
Rationale: Research is implemented through projects. The ways in which projects are managed and quality of research maintained are crucially important for the achievement of an organisation's objectives. Project management and quality assurance/improvement practices are needed to ensure effective research operations and quality of output.					
Questions	**Score**				**Evidence / Comments**
1. How effective are procedures for resource allocation at different levels (organisation, departments, program and project managers, stations, etc.)?	0	1	2	3	
2. How effectively are administrative procedures and logistic support for project implementation (procurement and distribution of equipment and materials, transport arrangements, etc.) carried out?					
3. To what extent are formal monitoring and review processes used to adjust or terminate projects and activities?					
4. How effectively do researchers present their findings in research reports?					
5. How often are research stations, substations, and labs reviewed to ensure adequate management, equipping, and organisation of experimental work?					
6. How effectively are researchers supported by technical and field staff?					
7. To what extent are established field and lab methods, and appropriate protocols used?					
8. To what extent do researchers have access to adequate scientific information (scientific journals, internet, international databases, advanced research institutes, universities etc.) that strengthens the quality of research?					
9. To what extent do researchers have access to computers and software that support the management and analysis of their research?					
Constraint statements	**Level of urgency**				**Evidence / Comments**

Management Area 6: Ensuring Qulity and Quantity of Scientific, Management and Technical Staff					
Rationale: Adequate numbers of well-qualified staff and effective management of human resources are key determinants of organisational performance. Establishing a cadre of qualified staff can take many years. If not managed properly, staff may become demotivated and leave the organisation, causing loss of valuable expertise. To keep pace with new developments in science, technology, and management, it is also essential to upgrade staff regularly. Staff planning, selection, recruitment, evaluation, and training are key components of human resources management that need to be in place and properly executed.					
Questions	**Score**				**Evidence / Comments**
1. To what extent does the organisation maintain and update staff information in a database (including biodata, disciplines, experience, publications, projects)?	0	1	2	3	
2. To what extent does the organisation plan and update its staffing, recruitment, and training requirements?					
3. How effectively are staffing, recruitment, and training plans linked to program and project needs?					
4. How effective are selection procedures (for management/scientific/support posts) in terms of objectivity and transparency?					
5. To what extent is training based on merit and organisation/program objectives?					
6. How effective are mechanisms to promote a good working environment and high staff morale?					
7. How effective is the performance evaluation process for research staff?					
8. How effective is the performance evaluation process for non-research (management, administrative, support) staff?					
9. How effective are reward and sanction processes, in terms of motivating staff?					
10. How effectively does the organisation compete with the private sector in providing salaries and benefits that attract and retain quality staff?					

ANNEXURE 3

Management Area 7: Protecting Organisational Assets					
Rationale: Organisational assets not only include staff (see Management Area 6), buildings, equipment, and finances, but also include assets such as knowledge, technologies developed (e.g. germplasm, machinery), intellectual property, and even credibility and reputation. A continuous effort is needed to protect all of these assets, because they are the basis for the sustainability of the organisation and allow it to continue delivering research and service outputs.					
Questions	**Score**				**Evidence / Comments**
1. How effectively can the organisation ensure protection of its mandate, statutory powers, and property?	0	1	2	3	
2. To what extent is infrastructure (buildings, stations, fields, roads) properly maintained?					
3. How well are vehicles and equipment (lab, field, office) maintained?					
4. How often is equipment inventoried?					
5. How effective is the organisation's overall funding strategy (e.g. in mobilising government and donor support, and identifying funding opportunities)?					
6. To what extent has the organisation identified opportunities for income generation and cost recovery (e.g. sale of products and services, consultancies)?					
7. How effectively does the organisation manage its financial resources?					
8. How effective are the organisation's accounting, financial reporting, and auditing procedures?					
9. To what extent are intellectual property rights of the institute protected?					
10. How effectively does the organisation promote itself (e.g. through public awareness activities and campaigns)?					

Management Area 8: Coordinating and Integrating the Internal Functions/Units/Activities Necessary for Organisational Outputs					
Rationale: The design of units (departments, divisions, committees, research stations, etc.) and of the mechanisms that guide interactions between them is a difficult task that is often neglected and results in performance problems. The structure of an organisation (as shown on its organogram) should reinforce and serve its strategy and functions. The organisation of these units (internal communication, governance, unit and individual terms of reference, etc.) and the overall structure need to be reviewed from time to time to ensure organisational coherence and the smooth and efficient running of operations. The planning and coordination of units, logistics, resources, and information flows are necessary to achieve integration and coherence.					
Questions	**Score**				**Evidence / Comments**
1. To what extent is the organisation's structure evaluated in relation to strategic considerations and adjusted accordingly?	0	1	2	3	
2. How often are the mechanisms for communication and coordination (e.g. internal memos, bulletins, meetings, standing committees) between structural/functional units updated, planned, and monitored?					
3. To what extent are overall direction and coordination of resources provided by a planning entity?					
4. To what extent are the tasks and functions of different units clearly described?					
5. To what extent are responsibilities of research and/or management staff clearly described in their terms of reference?					
6. To what extent are mandates, and terms of reference for committees and unit managers, prepared and updated?					
7. How effective is communication across different units/programs, and hierarchical levels?					
8. How effective is the externalgovernance body of the organisation (e.g. parent ministry, council, board of trustees, management board) in providing oversight and guidance?					
9. How effectively do the organisation's internalgovernance mechanisms (e.g. management committee, internal audit committee) function to develop and implement internal policies and regulations?					
10. To what extent is it possible to review and, if need be, improve the organisation's external and internal governance bodies?					
11. To what extent do reporting processes and forms exist that aid good management at different levels of the organisation?					

ANNEXURE 3

Management Area 9: Managing Dissemination and Partnerships					
Rationale: A fundamental requirement of research organisation management is the dissemination of technology and information to users. In addition, linking up with other actors in the agricultural knowledge and information system (including extension, farmer organisations, universities, private sector, international research, etc.) promotes information exchange, collaboration, and cost sharing, and ultimately improves the quality and relevance of research.					
Questions	**Score**				**Evidence / Comments**
1. To what extent does the organisation systematically define and plan linkages with its key partners?	0	1	2	3	
2. To what extent are responsibilities for linkages with partner organisations assigned?					
3. To what extent are linkages between research and extension organisations effectively maintained?					
4. How effectively does the organisation plan and carry out links with other actors involved in transfer/dissemination (NGOs, universities, commercial enterprises, etc.)?					
5. How effective is the system of feedback from different types of end users to researchers?					
6. To what extent are linkage costs included in the organisation's budgeting and allocation processes?					
7. To what extent are staff and financial resources for linkages adequate?					
8. How effectively are joint research-extension dissemination events planned and carried out?					
9. How frequently are joint (research-extension-user) reviews of technology transfer achievements carried out?					
10. To what extent do technology transfer and dissemination mechanisms (publications, media, field events) effectively communicate technology and information to users?					
11. To what extent is there effective participation of farmers and other end users in field trials, technology selection, and dissemination?					

Management Area 10: Ensuring Effective Monitoring, Evaluation and Reporting					
Rationale: Monitoring (assessing and adjusting ongoing research activities) and evaluation (judging the value, quality, and results of research) are key management processes because public-research organisations are under increasing pressure to account for their actions, use of resources, and results. Monitoring and evaluation are also important for determining whether or not a research organisation is learning from its earlier achievements and failures. Monitoring, evaluation, and reporting procedures need to be properly designed (i.e. integrated into project planning and implementation) and periodically reviewed, in order to provide useful information for decision making and accountability.					
Questions	**Score**				**Evidence / Comments**
1. To what extent does the organisation monitor and evaluate (M&E) its activities?	0	1	2	3	
2. How effectively is M&E used for research planning and decision making?					
3. How effectively does M&E serve organisation managers?					
4. How effectively does M&E serve donor reporting needs?					
5. To what extent are the costs of M&E (staff time, meetings, related travel) reasonable in relation to the overall budget?					
6. To what extent are M&E tasks planned, and responsibilities assigned?					
7. To what extent are M&E supported by an adequate management information system (MIS), which includes information on projects (e.g. costs, staff, progress, and results)?					
8. To what extent are research results and other outputs adequately reported internally (e.g. through reports, internal program reviews, seminars)?					
9. To what extent are research results and other outputs adequately reported, externally?					
10. To what extent do external stakeholders review the organisation's programs and management?					
11. To what extent do the financial management and accounting systems provide adequate information for timely decision making?					

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ABBREVIATIONS AND ACRONYMS

ABARE	-	Australian Bureau of Agricultural
AC	-	Adoption Cost
ADM	-	Arrow Diagram Method
ARO	-	Agricultural Research Organization
ASARECA	-	Association for Strengthining Agricultural Research in Eastern and Central Africa
c.i.f.	-	cost-insurance-freight
CBA	-	Cost-Benefit Analysis
CPI	-	Consumer Price Index
CPM	-	Critical Path Method
CS	-	Consumer Surplus
CV	-	Contingent Valuation
DNIB	-	Discounted Incremental Net Benefit
DRC	-	Domestic Research Cost
EIA	-	Environmental Impact Assessment
EU	-	European Union
f.o.b.	-	free on board
FSR	-	Farming Systems Research
GTZ	-	Deutsche Gesellschaft für Technische Zusammenarbeit
HH	-	Households
IL	-	Intervention Logic
INB	-	Incremental Net Benefit
IRR	-	Internal Rate of Return
ISNAR	-	International Service for National Agricultural Research
LFA	-	Logical Framework Analysis
M&E	-	Monitoring and Evaluation
MBO	-	Management by Objectives
MBE	-	Management by Exception
MIS	-	Management Information System
MRR	-	Marginal Rates of Return
MVP	-	Marginal Value Product
NARS	-	National Agricultural Research System
NB	-	Net Benefit
NGO	-	Non-Governmental Organization
NPV	-	Net Present Value
NPW	-	Net Present Worth
OBS	-	Organisational Breakdown Structure
OECD	-	Organization for Economic Co-operation and Development
OOIP	-	Objective Oriented Intervention Planning
OVI	-	Objectively Verifiable Indicator
PDM	-	Precedenia Diagram Method
PERT	-	Program Evaluation and Review Technique
PIM	-	Participatory Impact Monitoring
PM&E	-	Planning, Monitoring and Evaluation
PPI	-	Producer Price Index
PS	-	Producer Surplus
R&D	-	Research and Development
ROR	-	Rate of Return
SADC	-	Southern African Development Community
SOC	-	Social Opportunity Cost
STP	-	Social Time Preference
TDT	-	Technology Development and Transfer
UNIDO	-	United Nations Industrial Development Organization
USAID	-	United States Agency for International Development
WBS	-	Work Breakdown Structure
ZOPP	-	Ziel Orientierte Projekt Planung