ECONOMIC ANALYSIS OF AGRICULTURAL PROJECTS

J. Price Gittinger

Economic Development Institute
The World Bank

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PREFACE

This book was written to provide those responsible for agricultural investments in developing countries with sound analytical tools they can apply to estimate the income-generating potential of proposed projects.

Scope and Methodology

The book has not been written only for a narrow grouping of agricul-tural economists. Rather, it is intended for all who must share in shaping agricultural projects if these undertakings are to be high-yielding invest-ments: agronomists, livestock specialists, irrigation engineers, and many others. All these people are meant when the term "analyst" is used. To the existing resources of these diverse professionals, the book adds a tool for multidisciplinary use so that many with many skills can work together in applying their knowledge to analyze proposed projects.

The formal economic theory underlying the analytical system outlined here is not complicated; it certainly is not so technical as to cause problems for noneconomists. For those not already familiar with it, I have discussed the necessary economic theory in the course of the pre-sentation and have defined technical terms both in the text and in the glossary-index at the end of the book. The mathematical techniques used are also simple; they are limited to addition, subtraction, division, multiplication, and the simplest algebra. The computations needed for project analysis, however, are too tedious to be done by hand. A simple electronic calculator is a virtual necessity (see chapter 10 under "Calculator Applications in Project Analysis"), but there is no need for advanced calculators or computers.

The analytical system outlined in this book is a consistent statement of the general methodology currently employed by the World Bank for all but a few of its project analyses (Gittinger, Garg, and Thieme 1982). (The details of World Bank analyses vary somewhat according to the sector and the views of individual analysts.) With minor variations, the system is also used by most international agencies concerned with capital trans-fer, including the African Development Bank, the Asian Development Bank, and the Inter-American Development Bank. The economic analy-sis in this system is based on "efficiency prices"-prices that show effects on national income broadly defined. The system enables us to judge which among project alternatives is most likely to contribute the largest amount to national income. The system underlies millions of dollars of investment decisions made every year. Thick volumes of economic analy-sis backing up proposed investments usually involve nothing more com-plicated than what is discussed in the following pages-although large investments may require much elaboration and may involve intermedi-ate steps to accommodate all the "ins" and "outs" of a complex agri-cultural project.

In recent years several analytical systems have been proposed that extend the methodology outlined here to take into account not only the contribution a project makes to national income but also the effect of a project on income distribution and saving. Most notable are those of Little and Mirrlees (1974), the United Nations Industrial Development Organization (UNIDO) (1972a), and Squire and van der Tak (1975). These analytical systems, which remain the subject of much professional dis-cussion, are far more complex than the one I have presented. The system outlined here, however, is compatible with these more complex systems; in fact, Squire and van der Tak recommend the same methodology for project identification and valuation. The difference is that, once Squire and van der Tak have determined economic values on the basis of efficiency prices, they then proceed to weight those values to account for income distribution and saving. In the analytical system given here, we will stop with the efficiency price analysis. We will then suggest making a subjective decision to choose among the high-yielding alternatives the one that has the most favorable effects on income distribution, saving, and other national objectives. The system outlined here is not im-mediately adaptable to the Little and Mirrlees or the UNIDO systems, but there are no major conceptual differences up to the point we carry the analysis. Both Little and Mirrlees and UNIDO recommend further refine-ments to allow for the effects on income distribution and saving that are not incorporated in the formal analytical scheme recommended here.

Revised Edition

Compared with the first edition, published in 1972, this second, revised edition has an expanded discussion of the project approach that incorpo-rates more recent experience and provides more detailed and rigorous treatment of identifying, pricing, and valuing costs and benefits. The basic analytical system, however, is unchanged. Much additional mate-rial has been added on farm budgets and other aspects of financial analysis, and a bit more on the methodology of comparing costs and benefits.

In the Economic Development Institute (EDI), the first edition has been extensively used for teaching project analysis. The sequence of topics taken up in EDI courses on agricultural and rural development, rural credit, livestock, and irrigation projects generally follows the order found here. Thus, the overall concept of a project is presented first, followed by farm budgets and financial analysis, and then by economic analysis. (For a more detailed description of the process of project analy-sis, and of the organization of the chapters in this book, see the last section of chapter 1, "Steps in Project Analysis.") In practice, however, the methodology of comparing costs and benefits discussed in chapters 9 and 10 is usually taught in parallel with the topics on financial and economic analysis. This both permits a change of pace in the teaching and gives course participants more time to practice using methodologi-cal tools before proceeding to case studies in which they are asked to apply their knowledge of financial and economic analysis and their methodological skills. EDI has prepared a number of case studies and other training materials to teach agricultural and rural development project analysis, and these are available to others teaching these sub-jects. (See the last page of this book for information about how to obtain these materials.)
Acknowledgments

I could never have written a book such as this without extensive help from many, many people. The book grows out of lectures and training materials prepared for EDI courses, and its style reflects its origin. I have benefited enormously from, and this revised edition has been informed by, participants in these courses both at EM headquarters and in develop-ing countries. Readers will note I have made liberal use of training materials prepared by my colleagues.

It is impossible to acknowledge all the individuals who have helped me, but special appreciation should be expressed to Hans A. Adler, George B. Baldwin, Maxwell L. Brown, Colin F. M. Bruce, Orlando T.Espadas, F. Leslie C. H. Helmers, P. D. Henderson, William I. Jones, Klaus Meyn, Frank H. Lamson-Scribner, David H. Penny, Walter Schaef-er-Kehnert, Arnold von Ruemker, Jack L. Upper, and William A. Ward, all presently or formerly with the EDi; to numerous present and former staff working with agricultural projects in the World Bank, especially Graham Donaldson, Lionel J. C. Evans, John D. Von Pischke, Gordon Temple, Willi A. Wapenhans, and A. Robert Whyte; and to Frederick J. Hitzhusen, Ohio State University, and John D. MacArthur, University of Bradford.

USING THIS BOOK

The organization, conventions and notation, and special features of this book are briefly explained here at the outset for the reader's convenience.

Organization of Chapters

Chapters are presented in an order that in general follows the process of preparing an agricultural project analysis. The sequence of this pro-cess is described in the last section of chapter 1, "Steps in Project Analy-sis." Because the analytical process is iterative, chapters frequently contain cross-references to appropriate sections and subsections in other chapters.

Computations

Project analyses rest on many assumptions that by their very nature are only approximate. The final results of computations, therefore, should be rounded with this limitation in mind and presented appro-priately with only significant digits included-say, in millions or thousands of currency units, thousands or hundreds of tons or hectares, or the like. To make methodological points more apparent, however, many illustrative computations in this book have been carried out much further than called for by such a rule. Hence, they should not be taken as a model for presentation. (See the section in chapter 9 entitled "How Far to Carry Out Computations of Discounted Measures" for a discussion of this topic.)

Decimals and commas in numbers

Throughout this book, a decimal is indicated by a point set level with the bottom of the line of type (.). In numbers of 1,000 or greater (except those designating the year), a comma (,) distinguishes groupings of thousands. Thus, 1 million would be written 1,000,000.0. Whenever a decimal fraction appears that is less than 1, a zero appears before the decimal point to avoid misreading the fraction; thus, one-fourth appears in decimal form as 0.25.

Rounding convention

For all computations in this book, the following rules have been used for rounding:

- 1. When a value of less than 5 is to be dropped, the digit to the left is unchanged.
- 2. When a value of more than 5 is to be dropped, the digit to the left is increased by 1.
- 3. When a value of exactly 5 is to be dropped, the digit to the left, if even, is left unchanged; if odd, it is raised by 1. Under this rule, all numbers that have been rounded by dropping an exact value of 5 are reported as even numbers.
- Thus, in the first illustrative tabulation in the "Compounding" subsec-tion of chapter 9, the fol-lowing rounding will be found:
- 1,050 x 1.05 = 1,102.50 rounded to 1,102 (Rule 3) 1,102 x 1.05 = 1,157. 10 rounded to 1,157 (Rule 1) 1,157 x 1.05 = 1,214.85 rounded to 1,215 (Rule 2).

Calculations

Throughout the text, illustrative calculations made in project analysis are given (within parentheses or brackets) after the explanation of how they are derived. Most of these calculations are done by simple arithme-tic. (For the sake of completeness, there are many calculations presented in this manner that are very simple; I hope the reader will be patient with such obvious examples.) More elaborate formulas are displayed on the page.

Units of Measurement and Currency

Metric units are used for all measurements unless otherwise speci-fied-thus, "tons" refers to metric tons, not "long" or "short" tons. Special units-for example, "animal units" or "work days"-are defined in the text and in the glossary-index (see "Supporting Materials," below). To emphasize the worldwide scope of agricultural development efforts, examples of project accounts give money amounts in the cur-rency of the country in which the project is located. The standard sym-bols for these currencies are identified in the text and tables; when appropriate, generic "currency units" are also used.

Notation

An explanation of the conventions used for notation in this book may help in reading the tables, mathemat-ical formulations, and the six-decimal discount factors.

Tables

In the tables in this book a zero indicates "none" or "no amount," and a dash (-) indicates "not applicable." In chapters 4, 5, and 6, and in tables 9-7 and 9-8 where financial accounts are discussed, the accounting con-vention of indicating negative numbers by parentheses has been adopted. In all other tables, negative numbers are indicated by a minus sign (-).

The tables in this book are of several general kinds: tables that lay out methods of calculation (for example, tables 3-3 and 7-2); "pattern account" tables that lay out a recommended format for project accounts for either financial analysis (the tables in chapter 4) or economic analysis (the tables in chapter 7); and the usual sort of table that simply presents project data.

In some of the pattern account tables additional information for under-standing (for example, the financial or economic rate of return) is given after the main rows of entries. The reader is reminded that, to arrive at the total values in the tables of chapters *9* and 10 that include entries for multiyear spans, annual amounts must be included for the number of years involved.

In tables that illustrate financial accounts, the reader should note that in some cases intervening years have been omitted (see, for example, table 5-1).

To aid computation, portions of *Compounding and Discounting Tables for Project Evaluation* (Gittinger 1973) have been reproduced in the seven compounding and discounting tables that appear in this book.

Mathematics

As noted above, standard arithmetical notation has been used through-out the book. When division is indi-cated in a line of figures, a division sign (=) is used rather than a slash (/).

In the section in chapter 10 entitled "Calculator Applications in Project Analysis" the operations that are indicated on the keys of the simple electronic calculator used are shown in the text in boldface type.

Six-decimal discount factors

When six-decimal discount factors are used in the text or in tables, a notation of inserting a space between the third and fourth decimal places has been followed to make the factors easier to read.

Technical Terms

Specialized financial, accounting, economic, and project terms (and the few acronyms and abbreviations used in the book) have been com-piled and defined in the glossary-index (see "Supporting Materials," below). The most important of these, of course, are also defined in the text where they apply.As a guide to understanding the format of project accounts, the prin-cipal headings of the pattern account tables-catego-ries that are likely to appear in most agricultural project analyses-have been listed in *italic* type in the text of chapters 4, 5, 6, and 8.

Supporting Materials

The reader may find supporting materials that are included in this book, or available from the sources indi-cated, helpful for further study of project analysis.

Appendixes

Chapter appendixes supplement the discussion of topics in chapters 4, 8, and 9. Appendixes to the book provide general guidelines for preparing an agricultural project analysis report (appendix A); give sum-mary dis-counting tables for common discount rates and the formulas for comput-ing discount factors directly using an electronic calculator (appendix B); and discuss the bilateral and multilateral sources of specialized assist-ance for the preparation of complex agricultural projects (appendix C). The assistance discussed in appendix C is negotiated and undertaken at the institutional level by the agencies and govern-ments involved.

Bibliographic sources

Primary sources have been identified in the text by the author's sur-name and the publication date of the material cited. These sources, and additional references, are listed and annotated in the bibliogra-phy.Sources of some individual tables and figures are not listed in the bibliography but are cited in full in the appropriate table or figure legend. Some of these source materials have restricted circulation and are unavailable to the general public.

I could not have written this book without access to the experience of the Economic Development Institute (EM) and its parent institution, the World Bank. The record of this experience is predominantly in the pub-lic domain. Information about how to obtain publications of the EDi and of the World Bank will be found on the last page of this book.

Glossary-Index

As an aid to the reader, the index has been enhanced by incorporating glossary entries that define the principal technical terms used in this book. Because interpretation of some of these terms varies among the specialists involved in preparing agricultural project analyses (these professionals are an inquisitive lot-they have to be-and the field is a dynamic and changing one), the definitions given cannot be "defini-tive"-they reflect the use of these terms in this book.

Project examples

Data from actual agricultural project investments assisted by the World Bank or other international development agencies or financed by governments have been used to illustrate the analytical methodology presented here. The adaptation and interpretation of these data are my own. The use of project information in this book is purely illustrative; it does not represent a judgment by the funding agency or borrowing government about any particular project.

1. PROJECTS, THE CUTTING EDGE OF DEVELOPMENT

.Projects are the cutting edge of development. Perhaps the most difficult single problem confronting agricultural administrators in developing countries is implementing development programs. Much of this can be traced to poor project preparation.

Project preparation is clearly not the only aspect of agricultural development or planning. Identifying national agricultural development objectives, selecting priority areas for investment, designing effective price policies, and mobilizing resources are all critical. But for most agricultural development activities, careful project preparation in advance of expenditure is, if not absolutely essential, at least the best available means to ensure efficient, economic use of capital funds and to increase the chances of implementation on schedule. Unless projects are carefully prepared in substantial detail, inefficient or even wasteful expenditure is almost sure to result-a tragic loss in nations short of capital.

Yet in many countries the capacity to prepare and analyze projects lags. Administrators, even those in important planning positions, continually underestimate the time and effort needed to prepare suitable projects. So much attention is paid to policy formulation and planning of a much broader scope that administrators often overlook the specific

projects on which to spend available money and on which much development depends. Ill-conceived, hastily planned projects, virtually improvised on the spot, are too often the result.

What Is a Project?

In this book we will discuss how to compare the stream of investment and production costs of an agricultural undertaking with the flow of benefits it will produce. The whole complex of activities in the undertaking that uses resources to gain benefits constitutes the agricultural project. If this definition seems broad, it is intentionally so. As we shall see, the project format can accommodate diverse agricultural endeavors. An enormous variety of agricultural activities may usefully be cast in project form. The World Bank itself lends for agricultural projects as different as irrigation, livestock, rural credit, land settlement, tree crops, agricultural machinery, and agricultural education, as well as for multisectoral rural development projects with a major agricultural component. In agricultural project planning, form should follow analytical content.

We generally think of an agricultural project as an investment activity in which financial resources are expended to create capital assets that produce benefits over an extended period of time. In some projects, however, costs are incurred for production expenses or maintenance from which benefits can normally be expected quickly, usually within about a year. The techniques discussed in this book are equally applicable to estimating the returns from increased current expenditure in both kinds of projects.

Indeed, the dividing line between an "investment" and a "production" expenditure in an agricultural project is not all that clear. Fertilizers, pesticides, and the like are generally thought of as production expenses used up within a single crop season or, in any event, within a year. A dam, a tractor, a building, or a breeding herd is generally thought of as an investment from which a return will be realized over several years. But the same kind of activity may be considered a production expense in one project and an investment in another. Transplanting rice is a production expense. Planting rubber trees is an investment. But from the standpoint of agronomics and economics they are not different kinds of activities at all. In both cases young plants grown in a nursery are set out in the fields, and from them a benefit is expected when they mature. The only difference is the time span during which the plants grow.

Often projects form a clear and distinct portion of a larger, less precisely identified program. The whole program might possibly be analyzed as a single project, but by and large it is better to keep projects rather small, close to the minimum size that is economically, technically, and administratively feasible. Similarly, it is generally better in planning projects to analyze successive increments or distinct phases of activity; in this way the return to each relatively small increment can be

judged separately. If a project approaches program size, there is a danger that high returns from one part of it will mask low returns from another. A 100,000-hectare land settlement program may well be better analyzed as five 20,000-hectare projects if the soils and slopes in some parts are markedly different from those in others. Analyzing the whole project may hide the fact that it is economically unwise to develop some parts of the 100,000-hectare area instead of moving on to an entirely different region. When arranging for external financing or planning the administrative structure, it is sometimes convenient for planners to group several closely related projects into a single, larger "package." In these instances it may still be preferable to retain the separate analyses of individual components, in a composite of the whole, rather than to aggregate them into a single, overall analysis.

Again, all we can say in general about a project is that it is an activity for which money will be spent in expectation of returns and which logically seems to lend itself to planning, financing, and implementing as a unit. It is the smallest operational element prepared and implemented as a separate entity in a national plan or program of agricultural development. It is a specific activity, with a specific starting point and a specific ending point, intended to accomplish specific objectives. Usually it is a unique activity noticeably different from preceding, similar investments, and it is likely to be different from succeeding ones, not a routine segment of an ongoing program.

It will have a well-defined sequence of investment and production activities, and a specific group of benefits, that we can identify, quantify, and, usually in agricultural projects, determine a money value for.

If development can be pictured as a progression with many dimensions-temporal, spatial, sociocultural, financial, economic-projects can be seen as the temporal and spatial units, each with a financial and economic value and a social impact, that make up the continuum. A project is an undertaking an observer can draw a boundary around-at least a conceptual boundary-and say "this is the project." As well as its time sequence of investments, production, and benefits, the project normally will have a specific geographic location or a rather clearly understood geographic area of concentration. Probably there will also be a specific clientele in the region whom the project is intended to reach and whose traditional social pattern the project will affect.

Given the usefulness of the project format in the development process, the project has increasingly been used as a "time slice" of a long-term program for a region, a commodity, or a function such as agricultural extension. Although such projects normally have a definite beginning and end, the importance of these starting and finishing points is reduced. Such 'a use of the project format also makes quantification of benefits more difficult because some benefits may not be realized until subsequent phases of the program that are not included in the project. Often a project will have a partially or wholly independent administrative structure and set of accounts and will be funded through a specifically defined financial package. I hope that, after following the methodology presented here, readers will also subject their projects to an analysis of financial results and economic justification. People are sometimes concerned that they do not have an academic definition of what a project is. There is no need to be; in practice, the definition works itself out. There are much more important aspects of project analysis to grapple with than an academic formulation of a project definition.

Plans and Projects

Virtually every developing country has a systematically elaborated national plan to hasten economic growth and further a range of social objectives. Projects provide an important means by which investment and other development expenditures foreseen in plans can be clarified and realized. Sound development plans require good projects, just as good projects require sound planning. The two are interdependent.

Sound planning rests on the availability of a wide range of information about existing and potential investments and their likely effects on growth and other national objectives. It is project analysis that provides this information, and those projects selected for implementation then become the vehicle for using resources to create new income. Realistic planning involves knowing the amount that can be spent on development activities each year and the resources that will be required for particular kinds of investment.

Project selection must always be based in part on numerical indicators of the value of costs and returns. These can often be measured through valuation at the market prices-the prices at which goods or services are actually traded. Unfortunately, however, market prices may be misleading indicators of the use and return of real resources, so governments need to look at other aspects of potential investments to judge the real effects the investments will have. For this, good project analysis is a tremendous asset, since the investment proposal can be valued to reflect the true scarcity of resources when market prices do not. (Note that by market prices we refer to the actual prices at which goods and services are traded in a generalized system of exchange, not to the particular place at which the exchange takes place. To talk of a village "market" or a wholesale "market" is to use the word in a slightly different sense. This may seem an obvious distinction, but in project analysis it does make a difference whether the "market price" is collected in the appropriate "market," and we will return to this issue later.)

Well-analyzed projects often become the vehicle for obtaining outside assistance when both the country and the external financing agency agree on a specific project activity and know the amount of resources involved, the timing of loan disbursements, and the benefits likely to be realized. But project analysis should not be confined to only those investments for which external financing will be sought. The more investments there are that can be analyzed as projects, the more likely it is that the total use of resources for development will be efficient and effective. To concentrate a high proportion of available analytical skills on preparing projects for external assistance, and to leave investment of local resources basically unplanned, is a wasteful allocation of talent. If carefully designed and high-yielding projects are offset by essentially unplanned investments, then the net contribution to national objectives is substantially undermined.

Sound planning requires good projects, but effective project preparation and analysis must be set in the framework of a broader development plan. Projects are a part of an overall development strategy and a broader planning process; as such, they must fit appropriately. Governments must allocate their available financial and administrative resources among many sectors and many competing programs. Project analysis can help improve this allocation, but it alone cannot be relied upon to achieve the optimal balance of objectives. Within the broad strategy, analysts must identify potential projects that address the policy or production targets and priorities. Further, to make a realistic estimate about the course of a project, some idea must be gained of what other development activities will be taking place and what policies are likely to be pursued. Will employment growth make labor relatively more productive and thus more expensive to use in the project? Will input supplies be available at the time the project needs them? Will quotas be relaxed? Will food grain prices be allowed to rise? Integration of plans and projects becomes all the more important as the size of the project grows larger relative to the total economy. If the project alone is likely to have a significant effect on the availability of resources and on prices in the economy as a whole, then it must be very carefully planned in coordination with other investments and within an appropriate policy framework included in the national plan.

For the project itself, some elements used in agricultural project analysis should not be worked out in isolation by the individual analyst. All the projects being prepared and analyzed should use a consistent set of assumptions about such things as the relative scarcity of investment funds, foreign exchange, and labor. All project analyses should use the same assumptions about the social policies and objectives to be reflected in such decisions as the location of the project, the size of the landholding to be established, the amount of social services to be included, and the like.

Advantages of the Project Format

Projects carefully prepared, within the framework of broader development plans, both advance and assess the larger development effort. The project format itself is an analytical tool. The advantage of casting proposed investment decisions in the project format lies in establishing the framework for analyzing information from a wide range of sources. Because no plan can be better than the data and assumptions about the future on which it is based, the reality of the analysis to a large degree

depends on information from various sources and the considered judgments of various specialists in different areas. The project format facilitates gathering the information and laying it out so that many people can participate in providing information, defining the assumptions on which it is based, and evaluating how accurate it is.

The project format gives us an idea of costs year by year so that those responsible for providing the necessary resources can do their own planning. Project analysis tells us something about the effects of a proposed investment on the participants in the project, whether they are farmers, small firms, government enterprises, or the society as a whole. Looking at the effects on individual participants, we can assess the possible incentives a proposed project has and judge if farmers and others may successfully be induced to participate.

Casting a proposed investment in project form enables a better judgment about the administrative and organizational problems that will be encountered. It enables a strengthening of administrative arrangements if these appear to be weak and tells something of the sensitivity of the return to the investment if managerial problems arise. Careful project planning should make it more likely that the project will be manageable and that the inherent managerial difficulties will be minimal. The project format gives both managers and planners better criteria for monitoring the progress of implementation.

The project format encourages conscious and systematic examination of alternatives. The effects of a proposed project on national income and other objectives can conveniently be compared with the effects of projects in other sectors, of other projects in the same sector, or-very important-of alternative formulations of virtually the same project. One alternative can be the effects of no project at all.

Another advantage of the project format is that it helps contain the data problem. In many developing countries, national data are unavailable or are, to a substantial degree, unreliable. It is true that a project must be seen in a national context, but in many instances the direction that a country's development effort should take is well known, even if precise figures are not available. Most countries know they must increase food production even if they cannot cite reliable figures about total production or recent growth rates. By channeling much of the development effort into projects; the lack of reliable national data can be mitigated. Once the project area or clientele has been determined-once a conceptual boundary has been drawn-local information on which to base the analysis can be efficiently gathered, field trials can be undertaken, and a judgment can be made about social and cultural institutions that might influence the choice of project design and its pace of implementation. Investment can then proceed with confidence.

Because of the advantages of the project format in development planning, I would recommend that its use be extended to as many kinds of investment analysis as possible, even when this stretches the form. For projects of the production type-with clear-cut investments and easily valued costs and benefits, as is so often the case in agriculture-the project format is of course well suited. But many kinds of activities that might otherwise be thought of as programs can also be effectively cast in project form. Rural credit activities and even agricultural education, agricultural extension, and agricultural research can be put in project form to good effect, although the benefits from these kinds of projects may be impossible to value. In these instances, the orientation of the analysis may simply be changed to that of least-cost comparisons, and the other advantages of the project format will continue to be realized. These include systematic contributions to the preparation and review of the project by a wide range of specialists, carefully specified objectives, systematic consideration of alternatives, year-by-year estimates of cost, and the opportunity to examine carefully the organizational and managerial implications.

Limitations of the Project Format

Although the project format has many advantages, the results of project analysis must be interpreted with caution. Obviously, the quality of project analysis depends on the quality of the data used and of the forecasts of costs and benefits made. Here the GIGO principle-"garbage in, garbage out"-works with a vengeance. Unrealistic assumptions about yields, acceptance by farmers, response to incentives by entrepreneurs, the trend of future prices and the relative effect of inflation upon them, market shares, or the quality of project management can make garbage out of the project analysis.

To begin with, projects will exist in a changing technical environment. For some projects the possibility of technological obsolescence will affect judgments about the attractiveness of the investment. Fortunately, in agriculture this is not often a serious problem, although in other sectors it can be.

Because future circumstances will change, we must judge the risk and uncertainty surrounding a project, and here techniques of project analysis offer only limited help. It is impossible to quantify completely the risks of a project. We can, however, note that different kinds of projects or different formulations of essentially the same project may involve different degrees of risk. These differences will affect the choice of project design. We can also test a project for sensitivity to changes in some specific element, see how the benefit produced by the project will be affected, and then judge how likely it is that such changes will occur and whether the changes in benefits will alter our willingness to proceed. We could do such "sensitivity analysis," for example, by assuming that future yields will be less than our best estimate or that future prices will be lower than the level of our most likely projection, and then decide how probable such shortfalls will be and whether we still wish to continue with the project. Sensitivity analyses that simply assume "all costs increased by 10 percent" or "all benefits lowered by 10 percent," which are easy to perform if machine computation is used, are generally of littleusefulness; tests for specific changes that can lead to decisions on project design are far superior. Techniques have been developed for more formal analysis of risk, but they have not been widely applied to agricultural projects. They rest on assigning probabilities to a range of alternative assumptions. These techniques are complex and generally require machine computation.

Project analysis is a species of what economists call "partial analysis." Normally we assume that the projects themselves are too small in relation to the whole economy to have a significant effect on prices. In many instances, however, a proposed project is relatively large in relation to a national or regional economy. In this event we must adjust our assumptions about future price levels to take account of the impact of the project itself. At best, such adjustments are approximate and may severely limit the usefulness of the measures of project worth that will be discussed in chapter 9. Much more elaborate analytical procedures than those discussed here must then be called into play-generally some form of a programming model. Such techniques were used by the World Bank to analyze development of the Indus Basin in India and Pakistan, for instance (Lieftinck, Sadove, and Creyke 1968), and have been applied to regional agricultural development programs in Mexico (Norton and Solis 1982) and Brazil (Kutcher and Scandizzo 1981), among other countries. Even in those instances, however, the partiality of the assumptions means that the results must be interpreted with care.

The greater the differences among alternative projects, the more difficult it is to use formal analytical techniques to compare them. Financial and economic analyses of the sort discussed in this book are quite good for comparing such close alternatives as two versions of an irrigation project, or even an irrigation project and a land settlement project. They are relatively good for comparing alternative projects having costs and benefits that can be valued reasonably well-for instance, a project for a food processing plant and another for irrigation. But when we wish to compare projects whose benefits can be valued rather well (such as projects to increase agricultural output, or light manufacturing projects) with projects whose benefits cannot be valued (such as education or rural domestic water supply projects), then the formal techniques can hardly be used to determine the best alternative. In such instances, the allocation between different projects must be done more subjectively and as part of an overall development plan. The usefulness of the project format in these instances is not so much in facilitating comparison between two projects as in ensuring that both projects are planned so that they can be carried out efficiently.

By and large, project analysis is more useful when it is applied to unique investment activities. Ongoing services such as police and fire protection, extension services, export promotion, and even normal education services are probably better treated as part of a program than as individual projects. The project form works best where there is a rather clear investment-return cycle and a rather clear definition of geographical area or clientele.

Another limitation of the project format is an underlying conceptual problem about valuation based on the price system. The relative value of items in a price system depends on the relative weights that individuals participating in the system attach to the satisfaction they can obtain with their incomes. They choose among alternatives, and thus the prices of goods and services balance with the values attached to these goods and services by all who participate in the market. Such a system, however, reflects the distribution of income among its participants; in the end, values trace back to existing income distribution. Project analysis takes as a premise that inequities of income distribution can be corrected by suitable policies implemented over a period of time. If such a premise is not accepted, then the whole basis of the valuation system in project analysis (and of the underlying price system upon which it rests) is called into question.

Although project analysis must consciously be placed in a broader political and social environment, in general the effects of a project on this environment can be assessed only subjectively. Often economists refer to "externalities" or side effects, such as skill creation and the development of managerial abilities, that are by-products of a project. Projects may also be undertaken to further many objectives-such as regional integration, job creation, or improving rural living conditions-beyond economic growth alone. The less subject to valuing these objectives are, the less formal are the project analysis techniques that can be used to compare them, although the project format can still be effectively used to encourage careful planning and efficiency.

Furthermore, projects are not the only development initiatives that governments may undertake. The development process calls for such measures as good price policies, carefully designed tariff policies, and participation in discussions to obtain wider market access, and none of these lends itself easily to being cast in project form.

Projects are planned and implemented in a political environment. This is as it must be, since it is the political process that enables societies to balance many, often conflicting, objectives. But questions inevitably arise about the political overtones of project analysis. Is the "national" interest the same as the "social" interest? In project planning and analysis how do we adequately incorporate such considerations as national integrity, nation building, or national defense? One objective may be to benefit disadvantaged groups or regions, but projects in which these objectives are important may not always be the most remunerative. Political leaders must respond to all sorts of pressures, and the way they weigh various tradeoffs may not lead to the same conclusions a project analyst would reach.

All this is to say that, even though the analytical methods we will discuss can be of great help in identifying which projects will increase national income most rapidly, they will not make the actual decision of project investment. That decision is one on which many, many factors other than quantitative or even purely economic considerations must be brought to bear. A settlement project and a plantation project may have roughly similar economic benefits, but the settlement alternative may be chosen because it promises better income distribution benefits. Or, the analysis may reveal that the plantation project is more profitable and may give an idea of just how much so. Is the social benefit of the lower-paying project worth forgoing the probable future income from the higher-paying project? In the final analysis, any national investment decision must be a political act that embodies the best judgment of those responsible. The function of project analysis is not to replace this judgment. Rather, it is to provide one more tool (a very effective one, we hope) by which judgment can be sharpened and the likelihood of error reduced.

Aspects of Project Preparation and Analysis

To design and analyze effective projects, those responsible must consider many aspects that together determine how remunerative a proposed investment will be. All these aspects are related. Each touches on the others, and a judgment about one aspect affects judgments about all the others. All must be considered and reconsidered at every stage in the project planning and implementation cycle. A major responsibility of the project analyst is to keep questioning all the technical specialists who are contributing to a project plan to ensure that all relevant aspects have been explicitly considered and allowed for. Here we will divide project preparation and analysis into six aspects: technical, institutional-organizational-managerial, social, commercial, financial, and economic. These categories derive from those suggested by Ripman (1964), but alternative groupings would be equally valid for purposes of discussion.

Technical aspects

The technical analysis concerns the project's inputs (supplies) and outputs (production) of real goods and services. It is extremely important, and the project framework must be defined clearly enough to permit the technical analysis to be thorough and precise. The other aspects of project analysis can only proceed in light of the technical analysis, although the technical assumptions of a project plan will most likely need to be revised as the other aspects are examined in detail. Good technical staff are essential for this work; they may be drawn from consulting firms or technical assistance agencies abroad. They will be more effective if they have a good understanding of the various aspects of project analysis, but technical staff, no matter how competent, cannot work effectively if they are not given adequate time or if they do not have the sympathetic cooperation and informed supervision of planning officials.

The technical analysis will examine the possible technical relations in a proposed agricultural project: the soils in the region of the project and their potential for agricultural development; the availability of water, both natural (rainfall, and its distribution) and supplied (the possibilitiesfor developing irrigation, with its associated drainage works); the crop varieties and livestock species suited to the area; the production supplies and their availability; the potential and desirability of mechanization; and pests endemic in the area and the kinds of control that will be needed. On the basis of these and similar considerations, the technical analysis will determine the potential yields in the project area, the coefficients of production, potential cropping patterns, and the possibilities for multiple cropping. The technical analysis will also examine the marketing and storage facilities required for the successful operation of the project, and the processing systems that will be needed.

The technical analysis may identify gaps in information that must be filled either before project planning or in the early stages of implementation (if allowance is made for the project to be modified as more information becomes available). There may need to be soil surveys, groundwater surveys, or collection of hydrological data. More may need to be known about the farmers in the project, their current farming methods, and their social values to ensure realistic choices about technology. Field trials may be needed to verify yields and other information locally.

As the technical analysis proceeds, the project analyst must continue to make sure that the technical work is thorough and appropriate, that the technical estimates and projections relate to realistic conditions, and that farmers using the proposed technology on their own fields can realize the results projected.

Institutional-organizational-managerial aspects

A whole range of issues in project preparation revolves around the overlapping institutional, organizational, and managerial aspects of projects, which clearly have an important effect on project implementation.

One group of questions asks whether the institutional setting of the project is appropriate. The sociocultural patterns and institutions of those the project will serve must be considered. Does the project design take into account the customs and culture of the farmers who will participate? Will the project involve disruption of the ways in which farmers are accustomed to working? If it does, what provisions are made to help them shift to new patterns? What communication systems exist to bring farmers new information and teach them new skills? Changing customary procedures is usually slow. Has enough time been allowed for farmers to accept the new procedures, or is the project plan overly optimistic about rates of acceptance?

To have a chance of being carried out, a project must relate properly to the institutional structure of the country and region. What will be the arrangements for land tenure? What size holding will be encouraged? Does the project incorporate local institutions and use them to further the project? How will the administrative organization of the project relate to existing agencies? Is there to be a separate project authority? What will be its links to the relevant operating ministries? Will the staff be able to work with existing agencies or will there be institutional jealousies? Too often a project's organization simply builds up opposition within other agencies; at the very least, the project analyst must be sure such friction is minimized. He should arrange for all agencies concerned to have an opportunity to comment on the proposed organization of the project and ensure that their views enter in the deliberation to the fullest extent possible.

The organizational proposals should be examined to see that the project is manageable. Is the organization such that lines of authority will be clear? Are authority and responsibility properly linked? Does the organizational design encourage delegation of authority, or do too many people report directly to the project director? Does the proposed organization take proper account of the customs and organizational procedures common in the country and region? Or, alternatively, does it introduce enough change in organizational structure to break out of ineffective traditional organizational forms? Are ample provisions included for managers and government supervisors to obtain up-to-date information on the progress of the project? Is a special monitoring group needed? What about training arrangements? Does the project have sufficient authority to keep its accounts in order and to make disbursements promptly?

Managerial issues are crucial to good project design and implementation. The analyst must examine the ability of available staff to judge whether they can administer such large-scale public sector activities as a complex water project, an extension service, or a credit agency. If such skills are scarce or absent, should this be reflected in a less complex project organization? Perhaps the technical analysis of the project should be consulted and the project design concentrate on fewer or less complex technological innovations. When managerial skills are limited, provision may have to be made for training, especially of middle-level personnel. In some cases expatriate managers may have to be hired, and this may raise other problems, such as the acceptance of the project manager by the local people and the loss of the experience the expatriate manager gained while working on the project when the manager leaves the country. In many instances it would be preferable if possible to design the organization of the project to avoid the need for management services of expatriates.

In agricultural projects the analyst will also want to consider the managerial skills of the farmers who will participate. A project design that assumes new and complex managerial skills on the part of participating farmers has obvious implications for the rate of implementation. If farmers with past experience limited to crop production are to become dairy farmers, enough time must be allotted for them to gain their new skills; the project design cannot assume that they will be able to make the shift overnight. There must be extension agents who can help farmers learn the new skills, and provision must be made for these agents in the organizational design and in the administrative costs of the project.

In considering the managerial and administrative aspects of project design, not only are we concerned that managerial and administrative problems will eventually be overcome, but that a realistic assessment is made of how fast they will be resolved. The contribution an investment makes to creating new income is very sensitive to delays in project implementation.

Social aspects

We have mentioned the need for analysts to consider the social patterns and practices of the clientele a project will serve. More and more frequently, project analysts are also expected to examine carefully the broader social implications of proposed investments. We have noted proposals to include weights for income distribution in the formal analytical framework so that projects benefiting lower-income groups will be favored. In the analytical system outlined in this book, such weights are not incorporated, so it is all the more important in the project design that explicit attention be paid to income distribution.

Other social considerations should also be carefully considered to determine if a proposed project is as responsive to national objectives as it can be. There is a question about creating employment opportunities that is closely linked to, though not quite the same as, the question of income distribution. For social reasons, many governments want to emphasize growth in particular regions and want projects that can be implemented in these regions. The project analyst will want to consider carefully the adverse effects a project may have on particular groups in particular regions. In the past, the introduction of high-yielding seed varieties and fertilizers, coupled with the easy availability of tractors, has led to displacement of tenant farmers and has forced them into the ranks of the urban unemployed. Can the project be designed to minimize such effects, or be accompanied by policy changes that will? Changes in technology or cropping patterns may change the kind of work done by men and women. In some areas the introduction of mechanical equipment or of cash crops has deprived women of work they needed to support their children. Will a proposed project have such an adverse effect on the income of working women and their families?

There are also considerations concerning the quality of life that should be a part of any project design. A rural development project may well include provisions for improved rural health services, for better domestic water supplies, or for increased educational opportunities for rural children. Project analysts will want to consider the contribution of alternative projects or other designs of essentially the same project in furthering these objectives.

Those designing or reviewing projects will also want to consider the issue of adverse environmental impact (Wall 1979; Lee 1982). Irrigation development may reduce fish catches or increase the incidence of schistosomiasis in regions where this snail-transmitted disease is endemic, and waste from industrial plants may pollute water. Project sites may be selected with an eye to preserving notable scenic attractions or to preserving unique wildlife habitats. It is far better to ensure preservation of the environment by appropriate project design than to incur the expense of retrofitting technology or reclaiming land after an environmentally unsound project has been implemented.

Commercial aspects

The commercial aspects of a project include the arrangements for marketing the output produced by the project and the arrangements for the supply of inputs needed to build and operate the project.

On the output side, careful analysis of the proposed market for the project's production is essential to ensure that there will be an effective demand at a remunerative price. Where will the products be sold? Is the market large enough to absorb the new production without affecting the price? If the price is likely to be affected, by how much? Will the project still be financially viable at the new price? What share of the total market will the proposed project supply? Are there suitable facilities for handling the new production? Perhaps provision should be included in the project for processing, or maybe a separate marketing project for processing and distribution is in order (Austin 1981). Is the product for domestic consumption or for export? Does the proposed project produce the grade or quality that the market demands? What financing arrangements will be necessary to market the output, and what special provisions need to be made in the project to finance marketing? Since the product must be sold at market prices, a judgment about future government price supports or subsidies may be in order.

On the input side, appropriate arrangements must be made for farmers to secure the supplies of fertilizers, pesticides, and high-yielding seeds they need to adopt new technology or cropping patterns. Do market channels for inputs exist, and do they have enough capacity to supply new inputs on time? What about financing for the suppliers of inputs and credit for the farmers to purchase these supplies? Should new channels be established by the project or should special arrangements be made to provide marketing channels for new inputs?

Commercial aspects.of a project also include arrangements for the procurement of equipment and supplies. Are the procurement procedures such that undue delays can be avoided? Are there procedures for competitive bidding to ensure fair prices? Who will draw up the specifications for procurement?

Finally, there are the two aspects of project analysis that are the primary concerns of this book, the financial and the economic.

Financial aspects

The financial aspects of project preparation and analysis encompass the financial effects of a proposed project on each of its various participants. In agricultural projects the participants include farmers, private sector firms, public corporations, project agencies, and perhaps the national treasury. For each of these, separate budgets must be prepared, along lines suggested in chapters 4 through 6. On the basis of these budgets, judgments are formed about the project's financial efficiency, incentives, creditworthiness, and liquidity.

A major objective of the financial analysis of farms is to judge how much farm families participating in the project will have to live on. The analyst will need budget projections that estimate year by year future gross receipts and expenditures, including the costs associated with production and the credit repayments farm families must make, to determine what remains to compensate the family for its own labor, management skills, and capital. Part of the income the family will receive may be in food that is consumed directly in the household, so a judgment must be made about this quantity and its value. Even if a family realizes a considerable increase in income or "net incremental benefit" by participating in the project-as a result, say, of borrowing to purchase fertilizers to increase rice production-its absolute income may still be so low that nearly all of the incremental production is consumed in the household. Financial analysis must judge whether the family will then have sufficient cash to repay the production credit for fertilizer. If not, the analyst may have to make a policy judgment about how much to subsidize families with very low incomes.

The farm budget becomes the basis for shaping the credit terms to be made available. The analyst must judge whether farmers will need loans to finance on-farm investment (and if so, what proportion the farmers should invest from their own resources) or to meet some production costs, and whether seasonal short-term credit should be provided for working capital to finance inputs and pay for hired labor. In tree-crop projects with long development periods, such as those for oil palm or citrus, the analyst must judge whether farmers will have adequate income to live on during the period before the trees begin to bear, or whether special financing arrangements must be made to sustain them. The objective of all these judgments is to shape credit terms that will be generous enough to encourage farmers to participate in the project, yet be stiff enough that the society as a whole can capture fairly promptly a share of the benefit from the increased production. This benefit can, in turn, be used to hasten growth by relending it to other farmers or by reinvesting it elsewhere in the economy.

The analysis of farm income will also permit assessment of the incentives for farmers to participate in the project. What will be the probable change in farm income? What will be the timing of this change? How likely are price changes or fluctuations that could affect farm income severely enough that farmers will refuse to run the risk of participating in the project? What will be the effect of subsidy arrangements on farm income, and what changes in government policy might affect the income earned by farmers? Will new subsidies be needed to provide sufficient incentive for the project to proceed?

A similar group of considerations applies to the financial analysis of private firms involved in the project. Will they have capital for expanding facilities? Will they have the working capital needed to carry inventories of farm supplies or stocks of processed goods awaiting sale? What return will the firms realize on their capital investment, and is this sufficiently attractive?

An analysis of the financial aspects of the project's administration will also be needed. What investment funds will the project need and when? What will be the operating expenses when the project is under way? Will these expenses depend on budget allocations or will the project produce sufficient revenue to cover its administrative costs? Will changes in government policy be needed to finance the project, such as water charges levied in a new irrigation project? What about salary scales for project personnel? How will replacement of equipment be financed?

Finally, the fiscal impact of some projects will need to be considered. Will the increased output yield significant new tax revenues, perhaps from an export tax? Will new subsidies be needed to encourage farmers to participate, and how much will subsidies have to grow as project implementation proceeds? If the administrative costs of the project are not to be met from revenues, how will this affect the national budget in the future? If the project investment is to be financed by a grant or by borrowing from abroad, while the operation and maintenance cost is to be financed from domestic resources, how will this affect the treasury?

The methodology of discounted cash flow discussed in chapters 9 and 10 shows the way in which this financial analysis customarily is set up and the usual elements included in the cost and benefit streams. The methodology enables an estimate of the return to the equity capital of each of the various project participants, public or private. It is then a policy decision whether to change that return by income taxes, special lending terms, price subsidies, or any of the other tools open to society.

Economic aspects

The economic aspects of project preparation and analysis require a determination of the likelihood that a proposed project will contribute significantly to the development of the total economy and that its contribution will be great enough to justify using the scarce resources it will need. The point of view taken in the economic analysis is that of the society as a whole.

The financial and economic analyses are thus complementary-the financial analysis takes the viewpoint of the individual participants and the economic analysis that of the society. But, because the same discounted cash flow measures (discussed in chapter 9) are applied in the financial analysis to estimate returns to a project participant and in the economic analysis to estimate returns to society, confusion between the two analyses easily arises. There are three very important distinctions between the two that must be kept in mind. These qualifications are summarized here and are taken up in greater detail later.

First, in economic analysis taxes and subsidies are treated as transfer payments. The new income generated by a project includes any taxes the project can bear during production and any sales taxes buyers are willing to pay when they purchase the project's product. These taxes, which are part of the total project benefit, are transferred to the government, which acts on behalf of the society as a whole, and are not treated as costs. Conversely, a government subsidy to the project is a cost to the society, since the subsidy is an expenditure of resources that the economy incurs to operate the project. In financial analysis such adjustments are normally unnecessary; taxes are usually treated as a cost and subsidies as a return.

Second, in financial analysis market prices are normally used. These take into account taxes and subsidies. From these prices come the data used in the economic analysis. In economic analysis, however, some market prices may be changed so that they more accurately reflect social or economic values. These adjusted prices are called "shadow" or "accounting" prices and in the analytical system recommended here are efficiency prices, as noted earlier. In both financial and economic analysis projected prices are used, so both rely to a substantial extent on what are, in effect, hypothetical prices.

Third, in economic analysis interest on capital is never separated and deducted from the gross return because it is part of the total return to the capital available to the society as a whole and because it is that total return, including interest, that economic analysis is designed to estimate. In financial analysis, interest paid to external suppliers of money may be deducted to derive the benefit stream available to the owners of capital. But interest imputed or "paid" to the entity from whose point of view the financial analysis is being done is not treated as a cost because the interest is part of the total return to the equity capital contributed by the entity. Hence, it is a part of the financial return that entity receives.

The methodology of comparing costs and benefits discussed in chapters 9 and 10 is the same for either an economic or a financial measurement of project worth, but what is defined as a cost and what is considered a benefit are different. For the moment, it is enough to recognize that there is a difference between economic and financial analysis; we will discuss the differences in detail later.

Policymakers must be concerned about the investment of scarce capital resources that will best further national objectives. This is true whether the resources committed are being invested by the government directly or by individuals within the economy. The techniques of economic analysis presented here help identify those projects that make the greatest contribution to national income. The economic analysis in general allows for remuneration to labor and other inputs either at market prices or at shadow prices that are intended in the system recommended here to better approximate efficiency prices or "opportunity costs"-the amount we must give up if we transfer a resource from its present use to the project. The remainder is then compared with the capital stream necessary for the project. Those projects with the best return to capital, given the total resources available, are then selected for implementation. Inherent in this approach is the assumption that capital is the most important limit to faster economic growth. What is not implicit in the approach is that capital alone causes economic growth. All the productive factors combined in a project contribute to the new income created, but the methods we will be discussing do not address themselves to the question of what the proportionate contribution of each factor is.

We will apply the methods discussed here in economic (but not financial) analysis in such a way that the economic analysis does not itself address the issue of income distribution. Although the analysis will determine the amount of the income stream generated over and above the costs of labor and other inputs, it does not specify who actually receives it. Part of a project's benefit is usually taken through taxes for purposes outside the project. Part is generally made available to compensate capital owners (including governments) for the use of their money. Part may become the basis of an indirect transfer of income, as is the case if farmers benefiting from a land settlement project are charged less than the full cost of establishing their holdings. The economic analysis applied in this book is silent about such distribution. Once the analyst knows what the more economically remunerative alternatives are likely to be, however, he can choose those that have better effects on income distribution or other social objectives. Although the formal economic analysis will not decide issues of income distribution, the final decision on project investment will be an informed one that is then made in accord with views about income distribution.

Many economists prefer analytical systems that explicitly include income distribution weights. They note that the system outlined here accepts in its formal structure the income distribution as it exists in a society and does not distinguish projects that have the most desirable effects on income distribution. They argue that simply choosing projects subjectively from among the higher-yielding alternatives is not enough. Systems using income distribution weights are used infrequently, however, and most project investment decisions follow the general practice recommended here. Even economists who prefer using income distribution weights often recommend applying them only to that small fraction of projects in which there is reason to believe the weights might change an investment decision. Readers wishing to consult a fuller treatment of income distribution weights in project analysis may turn to Little and Mirrlees (1974) and Squire and van der Tak (1975).

Because economic analysis of a project as applied here tells us nothing about income distribution, it also tells us nothing about capital ownership. The value of a capital asset arises from the right to receive the future income the asset generates. Since our method of economic analysis does not specify who in the economy is to receive the income that a project earns, it does not address the question of who owns the capital. Economic measures of project worth reached by means of the analytical system outlined here help determine the most attractive alternative from the society's standpoint when the objective of the analysis is to increase national income. In this analytical frame, projects are equally valid whether the capital is to come from public revenue or private sources, whether there are income taxes or not, and whether the project is to be operated by public agencies or by individuals on their own behalf. In a manner analogous to the approach taken for income distribution, governments may then choose from economically remunerative projects those that lead to higher reinvestment and, hence, faster growth.

Some economists, however, take economic growth generated by investment, not income regardless of whether it is consumed or invested, as contituting at least part of their formal objective. If that is the case, then the source of the capital for a project makes a difference, as does who receives the benefits. A project financed by private sources that will consume all of the benefits will be less economically valuable than one in which all benefits accrue to a private individual who reinvests everything. Also, both will have values different from that of an identical project in which the benefit accrues to the government. As with income distribution weights, systems that weight capital sources or the investment use of benefits become quite complex. Again, the reader may refer to Little and Mirrlees (1974) and Squire and van der Tak (1975).

The Project Cycle

There tends to be a natural sequence in the way projects are planned and carried out, and this sequence is often called the "project cycle." As was the case with aspects of project analysis, there are many ways-all equally valid-in which this cycle may be divided. Here we will divide it into identification, preparation and analysis, appraisal, implementation, and evaluation. The sequence is adapted from an article by Baum (1978).

Identification

The first stage in the cycle is to find potential projects. There are many, many sources from which suggestions may come. The most common will be well-informed technical specialists and local leaders. While performing their professional duties, technical specialists will have identified many areas where they feel new investment might be profitable. Local leaders will generally have a number of suggestions about where investment might be carried out. Ideas for new projects also come from proposals to extend existing programs. A program to develop water resources will probably lead to suggestions of additional areas for irrigation. An existing land settlement program will probably generate suggestions of new areas for settlement.

Suggestions for new projects usually arise because some agricultural products are in short supply-or will be in a few years if production is not expanded or imports increased. The analysis may be based on general knowledge or upon a more systematic examination of market trends and import statistics. In addition, many countries have development banks intended to encourage growth of domestic industry. Often local firms will come to these banks with food processing proposals for which they are seeking finance.

Such project-by-project approaches may overlook important potential initiatives in agricultural development. Most developing countries have an economic development plan of some formality that identifies sectors to be given priority and areas where investment is needed. These generalized areas for priority are too vague to become the basis of investment themselves, but they lead to specific projects in crop or livestock production, land settlement, irrigation, food processing, expansion of export crop production, and the like. In the process of preparing an economic development plan, specific suggestions for projects usually will have come from the operating agencies responsible for project implementation, and these agencies may be encouraged to proceed with detailed project preparation.

Frequently, a separate sector survey of the current situation in agriculture will indicate what initiatives are needed. Such surveys may be undertaken with the help of an international agency or some agency for bilateral assistance. The sector survey will examine the current status of agriculture, project future needs for agricultural products over the next decade or so, and consider programs to improve the quality of rural life. It will examine prospects for expanding agricultural exports by considering potential increases in production and the outlook for marketing possibilities, and it will identify the gaps in existing plans and programs. The survey will probably generate suggestions about new areas for investment and the relative priority to be given different initiatives. It may even identify specific projects, especially larger ones, that merit consideration for future investment.

Occasionally one hears that there is a lack of projects available for investment in developing countries. Usually there is no shortage of proposals for projects that have been identified. But there may be a shortage of projects prepared in sufficient detail to permit implementation.

Preparation and analysis

Once projects have been identified, there begins a process of progressively more detailed preparation and analysis of project plans. This process includes all the work necessary to bring the project to the point at which a careful review or appraisal can be undertaken, and, if it is determined to be a good project, implementation can begin. In the preparation and analysis of projects, consideration will be given to each of the aspects discussed earlier.

The usual first step in project preparation and analysis is to undertake a feasibility study that will provide enough information for deciding whether to begin more advanced planning. The detail of the feasibility study will depend on the complexity of the project and on how much is already known about the proposal. Quite often a succession of increasingly detailed feasibility studies will be needed. The feasibility study should define the objectives of the project clearly. It should explicitly address the question of whether alternative ways to achieve the same objectives may be preferable, and it will enable project planners to exclude poor alternatives. The feasibility study will provide the opportunity to shape the project to fit its physical and social environment and to ensure that it will be high yielding.

Even at this early stage, the kind of financial and economic analyses discussed in this book should be brought into play. As projects are planned in greater and greater detail, the investment of time and money becomes more and more substantial, and the expectations of vested interests continue to grow. Being faced only at a late stage in the planning process with the decision to accept or reject a project on financial or economic grounds is obviously an uncomfortable position to be in. Far better that the financial and economic analyses enter early in the planning process, so that the feasibility studies introduce these aspects in the project plan.

The staff needed to work on feasibility studies will depend on how complex the studies are. To start, a single staff member may make a preliminary estimate in a relatively short time. Later the services of a small team, or perhaps outside consultants, may be engaged.

Once the feasibility studies have indicated which proposed project will likely be worthwhile, detailed planning and analysis may begin. By this time the less promising alternatives will have been eliminated, but even at this point the selected project will continue to be redefined and shaped as more and more becomes known. This is the stage at which detailed studies will commence-the carefully done soil surveys, the detailed hydrological analyses, the thorough examination of cropping patterns, the month-by-month estimates of labor requirements, the detailed farm budgets, and so forth. Again, all the aspects of analysis noted in the last section must be considered and correlated so that realistic estimates can be made of how the project might be implemented and of its likely income-generating capacity.

Detailed planning takes time, often a year or two or longer for complex agricultural projects. It may also be quite expensive. In agriculture, preparing the detailed project plan may well cost 7 to 10 percent of the total project investment. Yet thorough preparation increases a project's efficiency and helps ensure its smooth implementation in the future, so that the additional time and money required will probably be returned many times over by the increased return from the investment. Hastily prepared, superficial analyses will very likely yield projects that fall behind schedule, have lower returns, and waste scarce resources.

Preparation of the plan should itself be planned so that delays can be avoided and resources conserved. The timing of special studies needs to be considered, and the services of outside consultants should be scheduled so they will be available when needed-but not before the consultants' specialized knowledge can be used. The project may be prepared by a special team assembled for the purpose and given sufficient time and resources, or it may be prepared by a consulting firm or a technical assistance agency such as the Investment Centre of the Food and Agriculture Organization (FAO)

Appraisal

After a project has been prepared, it is generally appropriate for a critical review or an independent appraisal to be conducted. This provides an opportunity to reexamine every aspect of the project plan to assess whether the proposal is appropriate and sound before large sums are committed. The appraisal process builds on the project plan, but it may involve new information if the specialists on the appraisal team feel that some of the data are questionable or some of the assumptions faulty. If the appraisal team concludes that the project plan is sound, the investment may proceed. But if the appraisal team finds serious flaws, it may be necessary for the analyst to alter the project plan or to develop a new plan altogether.

If a project is to be financed by an international lending institution such as the World Bank or by a bilateral assistance agency, such an external lender will probably want a rather careful appraisal even if it has been closely associated with earlier steps in the project cycle. The World Bank, for example, routinely sends a separate mission to appraise proposed projects for which one of its member governments intends to borrow.

Implementation

The objective of any effort in project planning and analysis clearly is to have a project that can be implemented to the benefit of the society. Thus, implementation is perhaps the most important part of the project cycle. It is also clear, however, that considerations of implementation and project management are far too extensive for discussion here. Yet there are some aspects of implementation that are of particular relevance to project planning and analysis. The first, obviously, is that the better and more realistic a project plan is, the more likely it is that the plan can be carried out and the expected benefit realized. This emphasizes once again the need for careful attention to each aspect of project planning and analysis.

Second, project implementation must be flexible. Circumstances will change, and project managers must be able to respond intelligently to these changes. Technical changes are almost inevitable as the project progresses and more is known about soils, their response to nitrogen applications, susceptibility to waterlogging, and the like. Price changes may necessitate different cropping patterns or adjustments in inputs. Other changes in the project's economic or political environment will alter the way in which it should be implemented. The greater the uncertainty of various aspects of the project, or the more innovative and novel the project is, the greater the likelihood that changes will have to be made. Even as project implementation is under way, project managers will need to reshape and replan parts of the project, or perhaps the entire project. All of the general considerations we have discussed, as well as the analytical tools we will take up in detail in the following chapters, must be brought into play once again. Implementation is a process of refinement, of learning from experience-in effect, it is a kind of "mini-cycle" within the larger project cycle we have outlined.

Project analysts generally divide the implementation phase into three different time periods. The first is the investment period, when the major project investments are undertaken. In agricultural projects this usually extends three to five years from the start of the project. If the project is to be financed with the assistance of a loan from an external financing agency, the investment period may coincide with the agency's period for loan disbursements. Then, as its production builds up, the project is spoken of as being in the development period. This often takes an additional three to five years, but it may be extended if the project involves cattle herds, tree crops, or other investments with long gestation. The duration of the development period reflects not only physical factors but also the rate of adoption at which farmers take up new techniques. Once full development is reached, it continues for the life of the project. Usually the project life is keyed to the normal life of the major asset, although for practical reasons a project life rarely exceeds twenty-five to thirty years. Both the financial and economic analyses of the project relate to this time horizon.

Evaluation

The final phase in the project cycle is evaluation. The analyst looks systematically at the elements of success and failure in the project experience to learn how better to plan for the future. Evaluation is not limited only to completed projects. It is a most important managerial tool in ongoing projects, and rather formalized evaluation may take place at several times in the life of a project. Evaluation may be undertaken when the project is in trouble, as the first step in a replanning effort. It may be appropriate when a major capital investment such as a dam is in place and operating, even though the full implementation of the plan to utilize the water and power is still under way. Careful evaluation should precede any effort to plan follow-up projects. And, finally, evaluation should be undertaken when a project is terminated or is well into routine operation.

Evaluation may be done by many different people. Project management will be continuously evaluating its experience as implementation proceeds. The sponsoring agency-perhaps the operating ministry, the planning agency, or an external assistance agency-may undertake evaluation. In large and innovative projects, the project's administrative structure may provide a separate evaluation unit responsible for monitoring the project's implementation and for bringing problems to the attention of the project's management. Often the evaluation unit will include persons with planning skills who enable the unit to take part in any necessary replanning. The evaluation unit may also be responsible for planning follow-up projects.

In many instances, the project's management or the sponsoring agency will want to turn to outside evaluators. University staff may be well suited to undertake the task. Whoever does the evaluation will want to read the relevant documents carefully and then have extensive conversations with those who have had a part in the project-planners, project managers, operating staff, farmers participating in the project, or local people affected by the project.

The extent to which the objectives of a project are being realized provides the primary criterion for an evaluation. The objectives cannot be accepted uncritically, however; the inquiry should consider whether the objectives themselves were appropriate and suitable. The evaluators will want to know if these goals were made clear to the planners and to project management.

The project plan should be reviewed to see if it was an appropriate one in light of the objectives set forth. Each objective should be examined to determine whether it was considered carefully and whether appropriate provision for it was made in the project plan. Was the technology proposed appropriate? Were the institutional, organizational, and managerial arrangements suited to the conditions? Were the commercial aspects properly considered? Were the financial aspects carefully worked out on the basis of realistic assumptions, and were the economic implications properly explored? How did the project in practice compare with each aspect of the project analysis?

The evaluation should consider the response of project management and the sponsoring agencies to changing circumstances. Did management respond quickly enough to changes? Was its response carefully considered and appropriate? Did the institutional and organizational structure in the project permit a flexible response? How could the project's structure be altered to make the response to change more flexible and appropriate in the future?

From the evaluation should come carefully considered recommendations about how to improve the appropriateness of each aspect of the project design so that plans for project implementation can be revised if the project is ongoing and so that future projects can be better planned if the project evaluated has been completed.

Accuracy of Agricultural Project Analyses

Since agricultural project analyses are intended to become the basis for investment decisions, just how accurately do they foretell project results?

The World Bank systematically reviews the performance of projects for which it lends and publishes the results annually. These reviews generally are undertaken at the end of the implementation phase of the project. The most recent report, from which this section draws extensively, reviewed thirty-two agricultural projects for which performance audits were completed in 1980 (World Bank 1981 a). Although the particular projects reviewed by no means constitute a random sample, the results of the review confirm earlier trends and may be taken as generally indicative of all agricultural projects the World Bank finances. The projects included those for credit, irrigation, tree crops, fisheries, food crop production, livestock, storage, drought relief, and technical assistance.

Economic effects

Economic rates of return had been calculated at the time of appraisal for twenty-four of the projects included in the 1981 review and were reestimated at the time of the performance audit. (The other eight projects were either canceled before implementation or were of a nature-such as drought relief-that no rate of return was calculated.) The reestimates, of course, were done at the end of the implementation phase and so still included projections for the balance of the project life. Fourteen had rates of return that were within 2 percent of the rate estimated at appraisal or were greater than the appraisal estimate, and ten fell more than 2 percent below the rate of return estimated at appraisal. Of the twenty-four projects, nineteen had reestimated rates of return at the time of the review at or above 10 percent, a minimum acceptable rate in most developing countries. The rates of return alone, however, can be somewhat misleading. Several projects varied substantially from what was anticipated at the time of appraisal, but the variations were offsetting. One project that had an acceptable rate of return when reestimated at the time of the performance audit, for example, increased food grain output only about half as much as anticipated, but increases in grain prices offset the production shortfall and gave the project an acceptable rate of return.

For all projects taken together, the weighted reestimated return was 20 percent, well in line with the estimates of earlier years. Credit projects performed the best. They had an average rate of return of 26 percent, the lowest cost overruns and lower than average time overruns, and a clear advantage in reaching poor farmers. The largest subgroup, irrigation projects, had an average rate of return of 22 percent. In line with the results of previous surveys, "decentralized, small-scale groundwater and lift irrigation projects where each farmer develops his own potential were relatively smoothly implemented, resulted in lower costs per hectare, and proved extremely profitable. On the other hand, larger, centralized projects supported by detailed studies and designs and implemented by specialized agencies were beset with problems, were completed late and at much higher costs, resulted in high costs per hectare developed, and proved modestly profitable" (World Bank 1980, p. 29). The tree-crop projects had reestimated returns of 17 percent, substantially in line with the consistently good performance noted for this kind of project in earlier years. In the five projects that had unacceptable rates of return, the failure could generally be traced to a combination of inappropriate technology and poor management.

Effect on incomes of rural poor

The World Bank has been particularly pleased that performance reviews of the projects it finances demonstrate that agricultural projects focusing on small farmers and the rural poor perform as well as other projects in the sector. The 1980 review showed that rural development projects-those specifically designed to reach large numbers of small farmers and the rural poor-had an average return of 17 percent compared with the average of 20 percent for all other kinds of agricultural projects. "They have also reached ten times as many farmers per project, at a fraction of the cost of serving medium and larger farmers. Although the absolute amount of the income increases obtained through small farmer projects were a fraction of those received by medium and larger farmers, they were larger in relative terms . . ." Because they were received by so many farmers, "they had a substantial impact on income distribution" (World Bank 1980, p. 18).

Implementation experience

Of the thirty-two projects reviewed in 1981, only five were completed without delay or with delays of 10 percent or less. (This is much below the experience reported in earlier years, when about a third of the projects were completed on time.) Of the twenty-seven projects experiencing serious delays, fourteen were completed within 50 percent more time, six were completed in from 50 to 100 percent more time, and seven took more than twice as long to complete as scheduled at appraisal.

The experience of cost increases paralleled that of time delays. The average cost increase was 29 percent. Of the thirty-two projects, only twelve were completed with cost increases of 10 percent or less, five were within the range of 10 to 59 percent cost overrun, six were in the range of 50 to 100 percent overrun, and five cost twice or more the appraisal estimate.

The major reason for delay, which affected eight projects, was poor performance by executing agencies or contractors. The second most common cause, which affected six projects, was delay caused by bidding and procurement procedures. The third most common cause was delay due to unanticipated technical problems. As had been the experience in earlier reviews, the most common reasons for cost increases were general price inflation.and underestimation of unit costs at appraisal, but other reasons included increases in the scope of a project and in the total number of input units required. Delays in project implementation aggravated the effects of inflation.

Among subsector averages for timing of completion, tree-crop projects on the whole were completed on time or with very little delay, followed by credit projects, with an average time overrun of 31 percent, and livestock and irrigation projects, with an average delay of about 50 percent. The most serious delays were encountered in emergency rehabilitation projects, which took about twice as long as anticipated, and in technical assistance projects, which took 78 percent longer on the average than planned. No regional concentration of implementation delays was apparent.

The incidence of cost increases by subsector showed that the largest increases were in irrigation projects, which had an average cost overrun of 71 percent, an experience in line with that of earlier reviews. Time and cost overruns were thus both substantial in irrigation. Agricultural credit, area development, emergency relief and rehabilitation, and technical assistance projects were completed without, or with minor, cost increases; livestock projects had moderate increases; and tree-crop projects had substantial cost increases, on average 57 percent.

Of the thirty-two projects reviewed, twenty-seven were changed, formally or informally, during implementation. The most important causes were poor or incomplete original design, which affected fifteen cases; changes in government policies and strategies, which affected eleven cases; beneficiary preferences different from those anticipated, which affected seven cases; and impending cost overruns, which affected seven cases. Most projects were affected by a combination of these factors.

Shortcomings in design appear to have been a result of projects' being approved without sufficient preparation. Not all project changes during implementation, however, are undesirable or avoidable. Some projects are designed to be of a pilot nature, and in other projects changes in the price environment lead logically to changes in the mix of products. As the review noted, "project design should be sufficiently well developed to allow for immediate and straightforward project implementation but flexible enough to allow for adaptation without causing undue delay, wasted expenditures, or cost increases, all of which might reduce" the benefit of a project (World Bank 1981a, p. 34).

Why Agricultural Project Analyses Prove Wrong

When an agricultural project analysis proves to be a poor predictor of the actual outcome of a project, it may be that the project design or implementation is at fault, or it may be that the project analyst has done a poor job of incorporating a good project design in an analytical framework.

Problems of project design and implementation

The same World Bank performance audits used in the previous section to judge the accuracy of agricultural project analyses in estimating economic returns also examine the reasons for poor performance (World Bank 1980 and 1981a). In the most recent of these reviews and in an earlier summary of project experience prepared by Olivares (1978), the most common reasons agricultural projects run into problems of implementation may be grouped into five major categories: (1) inappropriate technology; (2) inadequate support systems and infrastructure; (3) failure to appreciate the social environment; (4) administrative problems, including those of the project itself and of the overall administration within the country; and (5) the policy environment, of which the most important aspect is producer price policy.

Inappropriate technology

Given the use and availability of land in most developing countries, increased crop production generally must depend on greater crop yields rather than on area extension. Thus, improved technology is a key element in most agricultural projects. Among the thirty-two projects in the 1981 review, as many as twenty-two depended on technological packages substantially new to the farmers in the project area. The introduction of new technology was concentrated in irrigation, tree-crop, rural development, and fisheries projects.

New technologies included a range of innovations. For irrigation projects, a farm input package with water as the main input was followed by improved seeds and further complemented by fertilizers and sometimes other inputs and improved cultural practices. For tree-crop projects, innovations took the form of improved cultural practices and equipment, early-maturing and high-yielding hybrids, and chemical instead of manual weed control. Rural development projects introduced farm input packages similar to those for irrigation; livestock projects emphasized pasture improvement; fisheries projects introduced improved fishing techniques and boats and equipment; and the storage project provided for modernized grain storage, pest control, and transport.

In fifteen of the projects reviewed, information was available about the effect of the technological innovation. In general, new technology was successful; eleven projects achieved or surpassed target yields. The major success factors appear to have been the appropriateness of the technology proposed for the given local conditions, the complementarity of recommended inputs, and the strength of the support systems (including research and extension to adapt the offered technologies to suit changing circumstances; see the section on infrastructure and support systems, below). In other projects, poor performance could be traced to inappropriate technology. In one project that failed to achieve the target yield, the failure of small farmers to apply more fertilizer was attributed to their desire to minimize risk by maximizing the return on a given investment rather than the return per hectare. In another project, farmers were ready to apply selected low-risk, productivity-raising inputs but not the entire package of recommended cultivation techniques. High density and early sowing, in particular, were largely rejected. Farmers preferred to avoid risk by staggering sowing dates and planting a larger number of low-density plots. The review concluded that "new technologies for dry farming should be more risk-reducing than those for irrigated farming where assured water supply eliminates much of the usual risk" (World Bank 1981a, p. 26).

Infrastructure and Support Systems

Of the thirty-two projects reviewed in 1981, twenty-eight could be viewed as part of an essential chain of support systems and infrastructure. The links in the chain include the relevant research, extension services, credit availability, input supply, and product markets; the importance of the chain lies in the introduction of technical packages, an essential element in most agricultural projects. These packages must first be developed and tested through research, adapted to the ecological conditions found in the project, and then delivered to the farmers through an adequately staffed, qualified, and motivated extension service that can then provide feedback for further research. In most cases, farmers do not have sufficient funds to purchase the recommended packages, and credit has to be made available. The input supply has to be organized, and this includes introduction of improved high-yielding varieties, provision of better livestock breeds, and the strategic location of stores where fertilizers, pesticides, and machinery such as pumps and their spare parts are available. Finally, the marketing of farm produce has to be organized in a manner that provides sufficient incentives to producers and avoids costly losses.

As may be expected, the content and detail of the support systems and infrastructure vary widely from project to project. In the projects reviewed, marketing systems received the most frequent attention (twenty out of twenty-eight projects), research support was given significant emphasis (seventeen projects), and credit and extension support received equal treatment (about one-half of the twenty-eight projects). Input supply systems received the least attention (one-third of the projects).

Deficiencies in the back-up research component were noted at appraisal in eight projects; in all cases a research component was included in the project, or arrangements were made for supporting research to be undertaken by an appropriate research group. In six of the eight projects, the research arrangements proved effective. In two cases, the projects suffered from lack of specific research, although both of these had included a research component in the original project design.

A major problem in agricultural and rural development projects is organizing farmers efficiently to provide them services, especially in their adapting new technology. The appropriate organization of farmers into self-help schemes is especially difficult, and the record of cooperatives has not been good. There are no easy solutions to these problems. A critical factor is to recognize at the project design stage that the small farmer will not take risks that could involve losing his livelihood and that some form of organizing farmers into self-help groups is essential to economical provision of government service.

Extension services were to be provided by the project unit in nine projects included in the 1981 review; in all but one of these the national extension service was judged to be inadequate. In general, these extension efforts were effective, but in two projects the extension effort failed to reach a minimum level of performance. In one project centered on grain production, output increased by only half the amount projected at appraisal. In the other, poor administration, including a failure to provide adequate extension, combined with poor design and unfavorable government policies to produce a negative return.

Credit was the major instrument for development in thirteen of the twenty-eight projects. It was used to promote a technical package in eight projects and other investment expenditures in the remaining five. The balance of the projects, with one exception, were clearly judged not to require credit.

Only a single input was supplied through the project in a number of cases, the full complement being provided in others. For the most part, inputs were supplied by the project units in estate projects where production was under full control of the project unit, or where small growers received credit in kind and were expected to follow specified production practices. In other projects that had an input supply component, the private sector met the needs.

Lack of marketing facilities is among the most difficult factors to provide for or change through projects directed mainly toward production. The principal marketing component in the projects was for the project unit to purchase the output of small producers. One project provided credit to market centers and cooperatives so that they could in turn provide advances to farmers for production and living expenses. One fisheries project provided cold storage facilities to improve marketing. Of the twenty-eight projects where infrastructure and support systems were central, only two were judged at audit to have been affected by lack of marketing facilities.

Sometimes the technical aspects of a project may be fairly well foreseen, but the social effects inadequately assessed. In one West African rice intensification project, progress was initially much slower than anticipated. A study revealed that in this area rice was produced by women, but that the credit needed for new inputs was channeled through institutions of which only men were members-and the men were not about to borrow for a woman's crop. When the national credit agency set up credit channels that could lend directly to women, implementation accelerated markedly.

In another African project, in an area of traditional extended family groupings a limit was established on individual loans for crop intensification. As a result, instead of the head of the family, who was responsible for allocating land to be cultivated, being able to borrow on behalf of the whole family, individual cultivators had to seek credit. Borrowing directly for production on their own account gave the cultivators a new, independent income. The impact of this change-whether good or bad-on the social structure of the area was not even considered by the analyst when the project was formulated (Olivares 1978).

The experience of the projects reported in the 1981 review reinforced conclusions about administrative structures reached in earlier reviews. Among the projects in the 1981 review, the performance level was high in ten of the twenty-two completed projects in which special efforts had been made to strengthen administrative and technical capabilities; partial success was achieved in another six; and the results were negligible in four. In line with the experience of previous years, there was frequently a close association between institutional and project performance. On the one hand, the three worst performers included in the 1981 review-all with negative rates of return-shared a pattern of weak management that was not corrected as implementation proceeded. On the other hand, nine of the best-performing projects reviewed in 1981 were implemented by agencies that were noted for good administration or that made special efforts to improve their administrative effectiveness during the implementation period. In at least one instance, an effort to improve the effectiveness of implementation paid dividends by enabling the agency to overcome initial administrative and design difficulties.

Past project performance reviews have led to the conclusion that "specially created project implementation units [have] an isolated and precarious existence, usually [run] into difficulties, and should, as far as possible, be avoided as a temporary device to by-pass institutional weaknesses and to insulate ... projects from the larger institutional environment" (World Bank 1981a, p. 27).

Staffing is a major problem in almost all development projects. Difficulties can be institutional-for example, restrictive governmental salary policies, civil service procedures, and promotion regulations-or can take the form of shortages of certain kinds of skilled people. One solution is often the use of consultants. Yet there frequently are difficulties between local project personnel and external consultants. Other common personnel problems include incompetent staff, ineffective training, high turnover, and poor matching of specific individuals with specific jobs.

Seven of the projects in the 1981 review made use of coordinating committees as an institutional instrument. As had been the case in earlier reviews, the experience was less than satisfactory. On the basis of this experience, the review concluded that "(1) high-level coordinating committees are generally not effective; (2) if formal coordination is needed, it should be established at the required technical or administrative level; and (3) a project unit within an existing organization may usefully undertake coordinating administrative functions" (World Bank 1981a, p. 28).

Delays in procurement will result in shortages of material, especially of foreign equipment. Sometimes delay is due to inadequate foresight and forward planning and sometimes (particularly in rural development projects) to unfamiliarity with procurement practices. The importance of timely procurement must be emphasized from the first stages of the project cycle and should be prominently included in the detailed implementation schedules.

Government administrative and managerial practices are at least as important to project implementation as the skills of project managers. If the central or local administrative processes are inadequate, the projects will encounter delays and, almost always, consequent cost increases. Common problems include slow and cumbersome decisionmaking, poor systems to authorize disbursement of project funds, ill-defined organizational arrangements, inadequate coordination among different agencies involved with a project, and, sometimes, government structures that deny appropriate authority to the project manager.

Policy Environment

Every project must be implemented within a framework of policies set by the government. If these are such that farmers' incentives are destroyed or other serious impediments are put in the way of project implementation, then the project cannot be expected to achieve satisfactory results.

The overriding importance of producer prices in affecting producer income, production levels, and economic efficiency was confirmed in the 1981 review. Prices contributed to expansion of production by encouraging farmers to participate in the project, to expand areas devoted to the project crops, and to use more inputs and thereby increase yields. The 1981 review analyzed project performance in relation to prices in eighteen projects. Eleven out of thirteen projects implemented under favorable prices achieved or surpassed their production objectives; all five under unfavorable prices failed to do so. Projects implemented under favorable prices offered an average rate of return at reestimate of 22 percent, whereas those under unfavorable prices averaged 10 percent.

The issue of producer prices was developed in more detail in the 1980 review (World Bank 1980). Producer price information was available from twenty-seven projects. Of those in which producer prices were judged unfavorable, 33 percent reflected low world market prices about which the individual country could do little, 25 percent had producer prices much below world market levels because of government decisions about price policy, and in the remaining 42 percent there was no direct link between the producer prices and the world market.

Depressed world market prices for dairy produce affected one agricultural credit project in a North African country. Local milk production had to compete with reconstituted milk, which was imported at very low prices. This hampered the dairy farm component of the project because farmers were unwilling to invest in uncompetitive dairy enterprises. In a large irrigation project in Latin America, about 70 percent of the cropped project area was originally planted with cotton when the project began operation in 1967 because farmers were encouraged by very high prices and readily available credit. As international prices declined, the area planted in cotton dropped to 40,000 hectares in 1973 and climbed back to 62,000 hectares in 1978 when the prices recovered again, but the area remained substantially below the 100,000 hectares projected at appraisal.

Government policy to tax farmers producing groundnuts and cotton kept the producer prices much below world market levels in two projects in one East African country, and the area under these crops fell 40 to 50 percent short of appraisal estimates. Another example comes from a tobacco project in another country in the same region. Producer prices for tobacco in the country increased 26 percent during the 1972-78 period, while world market prices went up 75 percent and the price of maize, a competing crop, by 226 percent. Government policies to tax export crops and equalize average returns on labor for all crops caused the farmer's share in the selling price of processed tobacco to decline from 66 percent in 1965-66 to 37 percent in 1977-78. As a result, tobacco production stagnated, and the project itself became economically viable only because farmers switched to higher-valued maize production.

Other projects suffering from low producer prices not directly linked to world market prices included: a commercial farming project in a third East African country in which poor handling of tobacco resulted in low quality and low prices; a project with a vegetable component in West Africa in which the project authority limited tomato production by paying low prices to farmers; and a Central American livestock project in which the freezing of milk prices caused most of the specialized dairy farms around the capital city to close down permanently.

In contrast, profitable producer prices-prevalent in only about 30 percent of the projects included in the 1980 review-had strong positive effects. In one livestock project, for instance, milk production after four years was already 50 percent of the target for full development after eight years, mainly because of the government's pricing policy for milk relative to beef. A West African cotton project similarly benefited from higher-than-expected world cotton prices. Although production targets were not met, farm income objectives were achieved, and cotton export earnings and targets for economic return were exceeded.

Such experiences, repeated over and over, emphasize the importance of taking price policies into account as a factor when designing and implementing agricultural projects.

Problems of poor project analysis

When a project analysis has failed to anticipate the outcome of a project investment, a common reason appears to have been simply poor preparation of the analysis. A number of such cases were analyzed in a review prepared by Olivares (1978), from which this section draws heavily.

Underestimated costs were common, either as a result of the analyst's being systematically optimistic about cost or making an especially poor estimate about the cost of particular components. Sometimes a component necessary for proper functioning of the project or an activity critical to the project was omitted from the cost estimates, even though in the same analysis it was noted that it would be essential to proper execution of the project. In the projects reviewed, components commonly omitted from the cost estimates (although not necessarily from the project and closely associated activities planned by the technicians) included agricultural extension to help farmers adopt new practices, training programs for project technicians, agronomic and livestock trials, complementary infrastructure such as roads or market facilities, and the expansion of the credit availability critical to the farmers' ability to adopt new techniques based on purchased inputs.

Excessively optimistic projections frequently were made during project preparation. In the projects reviewed, overestimates were common in projecting areas to be brought under cultivation, yields, rates of increase in livestock herds, and total production in the project area. The most common of these overestimates proved to be in cultivation intensity in irrigation projects and in the calving rate in cattle production projects. Project analyses frequently were too optimistic about the rate at which new cultivation practices would be adopted with irrigation, about the rate at which new areas would be brought under methods of improved cultivation, and about the rate at which the new technology could be applied under farm conditions.

When analyses of crop or livestock projects in rainfed areas did not predict the outcome well, the reason was often a failure to consider explicitly the variability of the climate and thus to overestimate returns. The analysis for one project undertaken in the Sahel region of Africa made no allowance for the variability of the climate, although the same analysis noted the likelihood of one or two dry years about once every five to seven years. The drought of 1973-75 paralyzed the project and forced planners to reevaluate and completely redesign the project. One livestock project in a Mediterranean country assumed that the weather during the project life would be "normal," despite the fact that in this region almost no year approaches this statistical computation. Nearly every particular year in the region is either too dry or too rainy, with the rains coming either too early or too late, and so forth. Naturally, making no allowance for this variability led to an overestimate of the project's yield and its attractiveness to the farmers involved.

Project evaluations commonly assumed too optimistic a calendar for project implementation. The analyses often did not test the effect on the project return of delays in getting the project under way-almost a normal situation in agricultural projects in general-or of delays in project execution at a later stage.

The return from investment in the agricultural projects examined was found to have been overestimated sometimes because the analysis failed to account for an adverse effect of the investment on production, either in the project area or elsewhere. In one project in Latin America, the main canals were lined to prevent water loss and to increase water delivery to the field. The analyst failed, however, to account for the irrigation of adjacent areas by wells recharged by seepage from the canals. The reduced output from these adjacent areas once the project was under way was not deducted from the benefits in the analysis. Of course, this led to an overestimate of the benefit from the irrigation project. Several irrigation projects in Asia were found to have reduced the spawning grounds of commercially important fish. The result was that much of the benefit from expanded irrigation was offset by a fall in fish production and reduced income for thousands of fishermen.

Project analysts often made errors when translating technical assumptions into projections of project performance. In one project it was assumed that 80 percent of the projected increase in area to be cultivated using more intensive technology would be reached in the first year, with the remaining 20 percent realized over the succeeding four years. In another project, expansion of the irrigated area was assumed to take place before the basic irrigation construction was to have been completed. In yet another case, the analyst assumed that fruit trees would reach full production the year they were planted. Such obvious errors could have been avoided just by cross-checking with the technical specialists as the analysis proceeded.

Steps in Project Analysis

Preparing a project analysis is anything but a neat, continuous process with well-defined steps, each of which is completed before the next and never retraced. Instead, the whole process is iterative; that is, the analyst must continuously go back and adjust earlier decisions in the light of what is learned from later analysis. In general, the process begins with an idea about the broad nature and objectives of a proposed project that has been supplied by the political or planning process. We will know, for example, that we are expected to prepare an irrigation project in a particular area, or a marketing project to reduce seasonal fluctuations in the price of an agricultural product, or an extension of an existing land settlement project. The next step is to examine carefully the pertinent technical relations on which to base the technical planning. We then begin to price these technical requirements and to develop some projections of inputs and outputs as the basis for the financial analysis. These financial prices are then adjusted to give economic values on which to base the economic analysis and to judge the project's contribution to the national income. At each step we must consider the institutional, organizational, and managerial aspects and the social effects. And, of course, at each step we may want to go back and revise earlier parts of the plan. The flow chart in figure 1-1 depicts this process schematically.

The sequence of topics in this book generally follows the order of the analytical process in preparing a financial, and then an economic, analysis of an agricultural project. We will not consider in detail the technical, institutional-organizational-managerial, social, or commercial aspects of preparing a project. Instead, we will assume that such preparations are already well in hand and that specialists knowledgeable in these matters can be easily consulted in the course of the analytical process.

We will turn first to what constitute costs and benefits in agricultural projects (chapter 2). Then we will proceed to how one can find market prices on which to base the project analysis (chapter 3). From these topics we will move on to discuss how these market prices can be transformed into accounts, which become the basis for the financial analysis, first by laying out and projecting model farm budgets (chapter 4). These projected farm budgets form the basis of an idea about how much a farm family participating in a project will have to live on as the project proceeds. This amount with the project, compared with what would be the amount without the project, yields an estimate about the incremental income that will accrue to the farm family. On the basis of this estimate, a judgment can be formed about the incentive effect of a proposed project on farmers who might participate. One can also estimate the rate of return to the farmer's own capital investment and to all capital invested on the farm.

By preparing and projecting budgets for agricultural processing indus'~ tries such as sugar mills or cotton gins that may be included in a project ii (chapter 5), one can make similar judgments about the incremental net benefit arising from investment in these firms, whether they are in the public or the private sector, and about the incentives for participation by the private sector if this is to be the vehicle for investment. A separate set of accounts for government agencies (chapter 6) will permit an estimate of the effect of the project on government revenue.

With these budgets in hand, the various market prices used in each are adjusted, if need be, to reflect economic values from the standpoint of the society as a whole (chapter 7). These economic values are then totaled or "aggregated," as it is more often termed (chapter 8). This is done for the incremental farm production from the project (either by aggregating according to model types for the total number of farms in the project or by aggregating the total area devoted to the various crops in the project), for all the revenueearning entities, and for the various government agencies. The aggregation gives the total incremental net benefit the society will realize from the project. From this and from earlier budgets, we can estimate the return that individuals and the society will realize from their investment in the project (chapters 9 and 10). Of course, at each stage in this sequence we will want to review our earlier work and revise it in light of later analysis.

The book concludes with a set of generalized guidelines for preparing reports of agricultural and rural development project analyses (appendix A), two discounting tables (appendix B), and a brief discussion about institutional sources of assistance for the preparation of agricultural projects (appendix C). An annotated bibliography and a glossary-index are included as references for the reader.

2. IDENTIFYING PROJECT COSTS AND BENEFITS

We undertake economic analyses of agricultural projects to compare costs with benefits 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. All of this is obvious enough, but frequently it is tricky business.

What costs and benefits in agricultural projects are, and how we can define them in a consistent manner, are the topics of this chapter. In chapter 3 we will examine how we can obtain market prices. After the financial analyses are discussed in chapters 4-6, the economic analysis is addressed in chapter 7 with a discussion of how to adjust market prices to reflect the real resource flows.

Objectives, Costs, and Benefits

In project analysis, the objectives of the analysis provide the standard against which costs and benefits are defined. Simply put, a cost is anything that reduces an objective, and a benefit is anything that contributes to an objective.

The problem with such simplicity, however, is that each participant in a project has many objectives. For a farmer, a major objective of participating is to maximize the amount his family has to live on. But this is only one of the farmer's interests. He may also want his children to be educated; as a result, they may not be available to work full time in the fields. He may also value his time away from the fields: a farmer will not adopt a cropping pattern, however remunerative, that requires him to work ten hours a day 365 days a year. Taste preference may lead a farmer to continue to grow a traditional variety of rice for home consumption even though a new, high-yielding variety might increase his family income more. A farmer may wish 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 his depending solely on the market for the food grains his family will consume. As a result, although he may be able to increase his income over time if he grows cotton instead of wheat or maize, he would rather continue growing food grains to forestall the possibility that in any one year the cotton crop might fail or that food grains might be available for purchase in the market only at a very high price. All these considerations affect a farmer's choice of cropping pattern and thus the income-generating capacity of the project. Yet all are sensible decisions in the farmer's view. In the analytical system presented here, we will try to identify the cropping pattern that we think the farmer will most probably select, and then we will judge the effects of that pattern on his incremental income and, thus, on the new income generated by the project.

For private business firms or government corporations, a major objective is to maximize net income, yet both have significant objectives other than simply making the highest profit possible. Both will want to diversify their activities to reduce risk. The private store owner may have a preference for leisure, which leads him to hire a manager to help operate his store, especially during late hours. This reduces the income-since the manager must be paid a salary-but it is a sensible choice. For policy reasons, a public bus corporation may decide to maintain services even in less densely populated areas or at off-peak hours and thereby reduce its net income. In the analytical system here, we first identify the operating pattern that the firms in the project will most likely follow and then build the accounts to assess the effects of that pattern on the income-generating capacity of the project.

A society as a whole will have as a major objective 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 may be reduced-which may be different from the objective of income distribution itself. Yet another objective may be to increase the proportion of savings in any given period so there will be more to invest, faster growth, and, hence, more income in the future. Or, there may be issues to address broader than narrow economic considerations-such as the desire to increase regional integration, to upgrade the general level of education, to improve rural health, or to safeguard national security. Any of these objectives might lead to the choice of a project (or a form of a project) that is not the alternative that would contribute most to national 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. In the analytical system here, we will take as formal criteria very straightforward objectives of income maximization and accommodate other objectives at other points in the process of project selection. The justification for this is that in most developing countries increased income is probably the single most important objective of individual economic effort, and increased national income is probably the most important objective of national economic policy.

For farms, we will take as the objective maximizing the incremental net benefit-the increased amount the farm family has to live on as a result of participating in the project-derived as outlined in chapter 4. For a private business firm or corporation in the public sector, we will take as the objective maximizing the incremental net income, to which we will return in chapter 5. And for the economic analysis conducted from the standpoint of the society as a whole, we will take as the objective maximizing 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. This is virtually the same objective, except for minor formal variations in definition, as maximizing gross domestic product (GDP). It is important to emphasize 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 our 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. For example, from among those projects that make generally the same contribution to increased income, we can choose the one that has the most favorable effects on income distribution, or the one that creates the most jobs, or the one that is the most attractive among those in a disadvantaged region.

Thus, in the system of economic analysis discussed here, anything that reduces national income 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 reduces the total final goods and services is obviously a cost, and anything that directly increases them is clearly a benefit. But recall, also, the intricate workings of the economic system. When the project analyzed uses some intermediate good or service-something that is used to produce something else-by a chain of events it eventually reduces the total final goods and services available elsewhere in the economy. On the one hand, if we divert an orange that can be used for direct consumption-and thus is a final good-to the production of orange juice, also a final good, we are reducing the total available final goods and services, or national income, by the value of the orange and increasing it by the value of the orange juice. On the other hand, if we use cement to line an irrigation canal, we are not directly reducing the final goods and services available; instead, we are simply reducing the availability of an intermediate good. But the consequence of using the cement in the irrigation project is to shift the cement away from some other use in the economy. This, in turn, reduces production of some other good, and so on through the chain of events until, finally, the production of final goods and services, the national income, is reduced. Thus, using cement in the project is a cost to the economy. How much the national income will be reduced by using the cement for the project is part of what we must estimate when we turn, in chapter 7, to deriving economic values. On the benefit side, we have a similar pattern. Lining a canal increases available water that, in turn, may increase wheat production, and so on through a chain of events until in the end the total amount of bread is increased.

By this mechanism, the project leads to an increase in the total amount of final goods and services, which is to say it increases the national income. Again, part of the analyst's task in the economic analysis is to estimate the amount of this increase in national income available to the society; that is, to determine whether, and by how much, the benefits exceed the costs in terms of national income. 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, a matter taken up in chapter 7.

Note that, by defining our objective for economic analysis in terms of change in national income, we are defining it in real terms. (Real terms, as opposed to money terms, refer to the physical, tangible characteristics of goods and services.) To an important degree, economic analysis, in contrast to financial analysis, consists in tracing the real resource flows induced by an investment rather than the investment's monetary effects.

With these objectives defined, we may then say that in financial analysis our numeraire-the common measurement used as the unit of account-is a unit of currency, generally domestic currency, whereas in economic analysis our numeraire is a unit of national income, generally also expressed in domestic currency. We will return to this topic in our discussion of determining economic values in chapter 7.

In the economic analysis we will assume that all financing for a project comes from domestic sources and that all returns from the project go to domestic residents. [This is one reason why we identify our social objective with the gross domestic product (GDP) instead of the more familiar gross national product (GNP).] This convention-almost universally accepted by project analysts-separates the decision of how good a project is in its income-generating potential from the decision of how to finance it. The actual terms of financing available for a particular project will not influence the evaluation. Instead, we will assume that the proposed project is the best investment possible and that financing will then be sought for it at the best terms obtainable. This convention serves well whenever financing can be used for a range of projects or even versions of roughly the same project. The only case in which it does not hold well is the rather extreme case in which foreign financing is very narrowly tied to a particular project and will be lost if the project is not implemented. Then the analyst may be faced with the decision of implementing a lower-yielding project with foreign financing or choosing a higher-yielding alternative but losing the foreign loan.

"With" and "Without" Comparisons

Project analysis tries 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 as 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 leads to an erroneous statement of the benefit attributable to the project investment.

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 Syria at the time the First Livestock Development Project was appraised, for example, production in the national sheep flock was projected to grow at about 1 percent a year without the project. The project was to increase and stabilize sheep production and the incomes of seminomadic flock owners and sheep fatteners by stabilizing the availability of feed and improving veterinary services. With the project, national flock production was projected to grow at the rate of 3 percent a year. 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 sheep production to the project investment. Actually, what can be attributed to the project investment is only the 2 percent incremental increase in production in excess of the 1 percent that would have occurred anyway (see figure 2-1).

A change in output can also occur without the project if production would actually fall in the absence of new investment. In Guyana, on the north coast of South America, rice and sugarcane are produced on a strip of clay and silt soil edging the sea. The coast was subject to erosion from wave action. Under the Sea Defense Project, the government of Guyana has built seawalls to prevent the erosion. The benefit from this project, then, is not increased production but avoiding the loss of agricultural output and sites for housing. A simple before-and-after comparison would fail to identify this benefit (figure 2-2).

In some cases, an investment to avoid a loss might also lead to an increase in production, so that the total benefit would arise partly from the loss avoided and partly from increased production. In Pakistan, many areas are subject to progressive salinization as a result of heavy irrigation and the waterlogging that is in part attributable to seepage from irrigation canals. Capillary action brings the water to the surface where evaporation occurs, leaving the salt on the soil. If nothing is done to halt the process, crop production will fall. A project is proposed to line some of the canals, thus to reduce the seepage and permit better drainage between irrigations. The proposed project is expected to arrest salinization, to save for profitable use the irrigation water otherwise lost to seepage, and to help farmers increase their use of modern inputs. The combination of measures would not only avoid a loss but also lead to an increase in production. Again, a simple before-and-after comparison would fail to identify the benefit realized by avoiding the loss (figure 2-3).

Of course, if no change in output is expected in the project area without the project, then the distinction between the before-and-after comparison and the with-and-without comparison is less crucial. In some projects the prospects for increasing production without new investment are minimal. In the Kemubu Irrigation Project in northeastern Malaysia, a pump irrigation scheme was built that permitted farmers to produce a second rice crop during the dry season. Without the project, most of the area was used for grazing, and with the help of residual moisture or small pumps some was used to produce tobacco and other cash crops. Production was not likely to increase because of the limited amount of water available. With the project now in operation, rice is grown in the dry season. Of course, the value of the second rice crop could not be taken as the total benefit from the project. From this value must be deducted the value forgone from the grazing and the production of cash crops. Only the incremental value could be attributed to the new investment in pumps and canals (figure 2-4).

Another instance where there may be no change in output without the project is the obvious one found in some settlement projects. Without the project there may be no economic use of the area at all. In the Alto Turi Land Settlement Project in northeastern Brazil, settlers established their holdings by clearing the forest, planting upland rice, and then establishing pasture for production of beef cattle. At the time the settlers took up their holdings the forest had not been economically exploited-nor was it likely to be, at least for many years, in the absence of the project. In this case, the output without the project would be the same as the output before the project (figure 2-5).

Direct Transfer Payments

Some entries in financial accounts really represent shifts in claims to goods and services from one entity in the society to another and do not reflect changes in national income. These are the so-called direct transfer payments, which are much easier to identify if our definition of costs and benefits is kept in mind. In agricultural project analysis four kinds of direct transfer payments are common: taxes, subsidies, loans, and debt service (the payment of interest and repayment of principal).

Take taxes, for example. In financial analysis a tax payment is clearly a cost. When a farmer pays a tax, his net benefit is reduced. But the farmer's payment of tax does not reduce the national income. Rather, it transfers income from the farmer to the government so that this income can be used for social purposes presumed to be more important to the society than the increased individual consumption (or investment) had the farmer retained the amount of the tax. Because payment of tax does not reduce national income, it is not a cost from the standpoint of the society as a whole. Thus, in economic analysis we would not treat the payment of taxes as a cost in project accounts. Taxes remain a part of the overall benefit stream of the project that contributes to the increase in national income.

Of course, no matter what form a tax takes, it is still a transfer payment-whether a direct tax on income or an indirect tax such as a sales tax, an excise tax, or a tariff or duty on an imported input for production. But some caution is advisable here. Taxes that are treated as a direct transfer payment are those representing a diversion of net benefit to the society. Quite often, however, government charges for goods supplied or services rendered may be called taxes. Water rates, for example, may be considered a tax by the farmer, but from the standpoint of the society as a whole they are a payment by the farmer to the irrigation authority in exchange for water supplied. Since building the irrigation system reduces national income, the farmer's payment for the water is part of the cost of producing the crop, the same as any other payment for a production input. Other payments called taxes may also be payments for goods and services rendered rather than transfers to the government. A stevedoring charge at the port is not a tax but a payment for services and so would not be treated as a duty would be. Whether a tax should be treated as a transfer payment or as a payment for goods and services depends on whether the payment is a compensation for goods and services needed to carry out the project or merely a transfer, to be used for general social purposes, of some part of the benefit from the project to the society as a whole.

Subsidies are simply direct transfer payments that flow in the opposite direction from taxes. If a farmer is able to purchase fertilizer at a subsidized price, that will reduce his costs and thereby increase his net benefit, but the cost of the fertilizer in the use of the society's real resources remains the same. The resources needed to produce the fertilizer (or import it from abroad) reduce the national income available to the society. Hence, for economic analysis of a project we must enter the full cost of the fertilizer.

Again, it makes no difference what form the subsidy takes. One form is that which lowers the selling price of inputs below what otherwise would be their market price. But a subsidy can also operate to increase the amount the farmer receives for what he sells in the market, as in the case of a direct subsidy paid by the government that is added to what the farmer receives in the market. A more common means to achieve the same result does not involve direct subsidy. The market price may be maintained at a level higher than it otherwise would be by, say, levying an import duty on competing imports or forbidding competing imports altogether. Although it is not a direct subsidy, the difference between the higher controlled price set by such measures and the lower price for competing imports that would prevail without such measures does represent an indirect transfer from the consumer to the farmer.

Credit transactions are the other major form of direct transfer payment in agricultural projects. From the standpoint of the farmer, receipt of a loan increases the production resources he has available; payment of interest and repayment of principal reduce them. But from the stand-point of the economy, things look different. Does the loan reduce the national income available? No, it merely transfers the control over resources from the lender to the borrower. Perhaps one farmer makes the loan to his neighbor. The lending farmer cannot use the money he lends to buy fertilizer, but the borrowing farmer can. The use of the fertilizer, of course, is a cost to the society because it uses up resources and thus reduces the national income. But the loan transaction does not itself reduce the national income; it is, rather, a direct transfer payment. In reverse, the same thing happens when the farmer repays his loan. The farmer who borrowed cannot buy fertilizer with the money he uses to repay the loan his neighbor made, but his neighbor can. Thus, the repayment is also a direct transfer payment.

Some people find the concept of transfer payments easier to understand if it is stated in terms of real resource flows. Taking this approach in economic analysis, we see that a tax does not represent a real resource flow; it represents only the transfer of a claim to real resource flows. The same holds true for a direct subsidy that represents the transfer of a claim to real resources from, say, an urban consumer to a farmer. This line of reasoning also applies to credit transactions. A loan represents the transfer of a claim to real resources from the lender to the borrower. When the borrower pays interest or repays the principal, he is transferring the claim to the real resources back to the lender-but neither the loan nor the repayment represents, in itself, use of the resources.

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 (our objectives in financial analysis), or the national income (our objective in economic analysis).

Physical goods

Rarely will physical goods used in an agricultural project be difficult to identify. For such goods as concrete for irrigation canals, fertilizer 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.

Labor

Neither will the labor component of agricultural projects be difficult to identify. From the highly skilled project manager to the farmer maintaining his orchard while it is coming into production, the labor inputs raise less a question of what than of how much and when. Labor may, however, raise special valuation problems that call for the use of a shadow price. Confusion may also arise on occasion in valuing family labor. Valuing family labor will be discussed with farm budgets in chapter 4, and the overall question of valuing unskilled labor will be taken up in chapter 7.

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. Yet problems may arise in valuing land because of the very special kind of market conditions that exist when land is transferred from one owner to another. These valuation problems will also be considered with farm budgets in chapter 4 and with determining economic values in chapter 7.

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; no exceptional conditions such as unanticipated geological formations; and no adverse phenomena such as floods, landslides, or unusually bad weather. 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 costs. Contingency allowances are thus included as a regular part of the project cost estimates.

Contingency allowances may be divided into those that provide for physical contingencies and those for price contingencies. In turn, price contingency allowances comprise two categories, those for relative changes in price and those for general inflation. Physical contingencies and price contingencies that provide for increases in relative costs underlie our expectation that physical changes and relative price changes are likely to occur, even though we cannot forecast with confidence just how their influence will be felt. The increase in the use of real goods and services represented by the physical contingency allowance is a real cost and will reduce the final goods and services available for other purposes; that is, it will reduce the national income and, hence, is a cost to the society. Similarly, a rise in the relative cost of an item implies that its productivity elsewhere in the society has increased; that is, its potential contribution to national income has risen. A greater value is forgone by using the item for our project; hence, there is a larger reduction in national income. Physical contingency allowances and price contingency allowances for relative changes in price, then, are expected-if unallocated-project costs, and they properly form part of the cost base when measures of project worth are calculated.

General inflation, however, poses a different problem. As we will note in chapter 3 in discussing future prices, 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. Contingency allowances for inflation would not, however, be included among the costs in project accounts other than the financing plan.

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 (since such payment does not reduce the national income). The amount that would be deducted for taxes in the financial accounts remains in the economic accounts as part of the incremental net benefit and, thus, part of the new income generated by the project.

Debt service

The same approach 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.

Treatment of interest during construction can give rise to confusion. Lending institutions sometimes add the value of interest during construction to the principal of the loan and do not require any interest payment until the project begins to operate and its revenues are flowing. This process is known as "capitalizing" interest. The amount added to the principal as a result of capitalizing interest during construction is similar to an additional loan. Capitalizing interest defers interest cost, but when the interest payments are actually due, they will, of course, be larger because the amount of the loan has been increased. From the standpoint of economic analysis, the treatment of interest during construction is clear. It is a direct transfer payment the same as any other interest payment, and it should be omitted from the economic accounts. Often interest during construction is simply added to the capital cost of the project. To obtain the economic value of the capital cost, the amount of the interest during construction must be subtracted from the capital cost and omitted from the economic account.

In economic analysis, debt service is treated as a transfer within the economy even if the project will actually be financed by a foreign loan and debt service will be paid abroad. This is because of the convention of assuming that all financing for a project will come from domestic sources and all returns from the project will go to domestic residents. This convention, as noted earlier, separates the decision of how good a project is from the decision of how to finance it. Hence, even if it were expected that a project would be financed, say, by a World Bank loan, the debt service on that loan would not appear as a cost in the economic accounts of the project analysis.

Sunk costs

Sunk costs are those costs incurred in the past upon which a proposed new investment will be based. Such costs cannot be avoided, however poorly advised they may have been. When we analyze a proposed investment, we consider only future returns to future costs; expenditures in the past, or sunk costs, do not appear in our accounts.

In practice, if a considerable amount has already been spent on a project, the future returns to the future costs of completing the project would probably be quite attractive even if it is clear in retrospect that the project should never have been begun. The ridiculous extreme is when only one dollar is needed to complete a project, even a rather poor one, and when no benefit can be realized until the project is completed. The "return" to that last dollar may well be extremely high, and it would be clearly worthwhile to spend it. But the argument that because much has already been spent on a project it therefore must be continued is not a valid criterion for decision. There are cases in which it would be preferable simply to stop a project midway or to draw it to an early conclusion so that future resources might be freed for higher-yielding alternatives.

For evaluating past investment decisions, it is often desirable to do an economic and financial analysis of a completed project. Here, of course, the analyst would compare the return from all expenditures over the past life of the project with all returns. But this kind of analysis is useful only for determining the yield of past projects in the hope that judgments about future projects may be better informed. It does not help us decide what to do in the present. Money spent in the past is already gone; we do not have as one of our alternatives not to implement a completed project.

Tangible Benefits of Agricultural Projects

Tangible benefits of agricultural projects can arise either from an increased value of production or from reduced costs. The specific forms in which tangible benefits appear, however, are not always obvious, and valuing them may be quite difficult.

Increased production

Increased physical production is the most common benefit of agricultural projects. An irrigation project permits better water control so that farmers can obtain higher yields. Young trees are planted on cleared jungle land to increase the area devoted to growing oil palm. A credit project makes resources available for farmers to increase both their operating expenditures for current production-for fertilizers, seeds, or pesticides-and their investment-for a tubewell or a power thresher. The benefit is the increased production from the farm.

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 prove too difficult, although there may be a problem in determining the correct value to use in the economic analysis.

In many agricultural projects, however, the benefits may well include increased production consumed by the farm family itself. Such is the case in irrigation rehabilitation projects along the north coast of Java. The home-consumed production from the projects increased 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.

When home-consumed crops will figure prominently in a project, the importance of careful financial analysis is increased. In this case, it is necessary to estimate not only the incremental net benefit-including the value of home-consumed production and money from off-farm sales-but also the cash available to the farmer. From the analysis of cash income and costs, one can determine if farmers will have the cash in hand to purchase modern inputs or to pay their credit obligations. It is possible to have a project in which home-consumed output increases enough for the return to the economy as a whole to be quite attractive, but in which so little of the increased production is sold that farmers will not have the cash to repay their loans.

Quality improvement

In some instances, the benefit from an agricultural project may take the form of an improvement in the quality of the product. For example, the analysis for the Livestock Development Project in Ecuador, which was to extend loans to producers of beef cattle, assumed that ranchers would be able not only to increase their cattle production but also to improve the quality of their animals so that the average live price of steers per kilogram would rise from S/5.20 to S/6.40 in constant value terms over the twelve-year development period. (The symbol for Ecuadorian sucres is S/.) Loans to small dairy farmers in the Rajasthan Smallholder Dairy Improvement Project in India are intended to enable farmers not only to increase output but also to improve the quality of their product. Instead of selling their milk to make ghee (cooking oil from clarified butter), farmers will be able to sell it for a higher price in the Jaipur fluid milk market. As in these examples, both increased production and quality improvement are most often expected in agricultural projects, although both may not always be expected. One word of warning: both the rate and the extent of the benefit from quality improvement can easily be overestimated.

Change in time of sale

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 favorable. A grain storage project may make it possible to hold grain from the harvest period, when the price is at its seasonal low, until later in the year when the price has risen. The benefit of the storage investment arises out of this change in "temporal value."

Change in location of sale

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. For example, the Fruit and Vegetable Export Project in Turkey included provision for trucks and ferries to transport fresh produce from southeastern Turkey to outlets in the European Common Market. The benefits of such projects arise from the change in "locational value."

In most cases the increased value arising from marketing projects will be split between farmers and marketing firms as the forces of supply and demand increase the price at which the farmer can sell in the harvest season and reduce the monopolistic power of the marketing firm or agency. Many projects are structured to ensure that farmers receive a larger part of the benefit by making it possible for them to build storage facilities on their farms or to band together into cooperatives, but an agricultural project could also involve a private marketing firm or a government agency, in which case much of the benefit could accrue to someone other than farmers.

Changes in product form (grading and processing)

Projects involving agricultural processing industries expect benefits to arise from a change in the form of the agricultural product. Farmers sell paddy rice to millers who, in turn, sell polished rice. The benefit to the millers arises from the change in form. Canners preserve fruit, changing its form and making it possible at a lower cost to change its time or location of sale. Even a simple processing facility such as a grading shed gives rise to a benefit through changing the form of the product from run-of-the-orchard to sorted fruit. In the Himachal Pradesh Apple Marketing Project in northern India, the value of the apples farmers produce is increased by sorting; the best fruit is sold for fresh consumption while fruit of poorer quality is used to make a soft drink concentrate. In the process, the total value of the apples is increased.

Cost reduction through mechanization

The classic example of a benefit arising from cost reduction in agricultural projects is that gained by investment in agricultural machinery to reduce labor costs. Examples are tubewells substituting for hand-drawn or animal-drawn water, pedal threshers replacing hand threshing, or (that favorite example) tractors replacing draft animals. 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 labor 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 realized may be distributed among farmers, truckers, and consumers.

Losses avoided

In discussing with-and-without comparisons in project analyses earlier in this chapter, 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. In Jamaica, lethal yellowing is attacking the Jamaica Tall variety of coconut. The government has undertaken a large investment to enable farmers to plant Malayan Dwarf coconuts, which are resistant to the disease. Total production will change very little as a result of the investment, yet both the farmers and the economy will realize a real benefit because the new investment prevents loss of income. The Lower Egypt Drainage Project involves the largest single tile drainage system in the world. The benefit will arise not from increasing production in the already highly productive Nile delta, but from avoiding losses due to the waterlogging caused by year-round irrigation from the Aswan High Dam.

Sometimes a project increases output through avoiding loss-a kind of double classification, but one that in practice causes no problem. Proposals to eradicate foot-and-mouth disease in Latin America envision projects by which the poor physical condition or outright death of animals will be avoided. At the same time, of course, beef production would be increased.

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, as noted earlier, but also 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. Since this is an imputed value, there are valuation problems that will be noted later.

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. (Of course, this applies only in economic analysis; the problem does not arise in financial analysis.)

When market prices are used in economic analysis, as has been the custom in the United States for water resource and other public works projects, it is necessary to estimate the secondary costs and benefits and then add them to the direct costs and benefits. This is a theoretically difficult process, and one easily subject to abuse. There is an extensive and complex literature on secondary costs and benefits that specifically addresses this analytical approach. For those who would like to review this literature, a good place to begin is the article by Prest and Turvey (1966), which outlines the historical development of the discussion. A highly technical review of the arguments can be found in Mishan (1971).

Instead of adding on secondary costs and benefits, one can either adjust the values used in economic analysis or incorporate 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, in the systems based on shadow prices proposed in more recent literature on project analysis, and in the analytical system presented here.

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 here, as will be explained in more detail in chapter 7, every item is valued either at its opportunity cost or at a value determined by a consumer's willingness to pay for the item. The effect is to eliminate all transfers-both the direct transfers discussed earlier in this chapter and the indirect transfers that arise because prices differ from opportunity costs. 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.

One qualification must be made. If a project has a substantial effect on the quantity other producers are able to sell in imperfect markets-and most markets are imperfect-there may be gains or losses not accurately accounted for. Squire and van der Tak (1975, p. 23) cite the example of an improved road that diverts traffic from a railway that charges rates below marginal cost. This diversion entails a social gain from reduced rail traffic (in avoiding the social losses previously incurred on this traffic) in addition to the benefits to the road users measured directly. In agricultural projects, this is a rather infrequent case because prices generally are more flexible than in other sectors of the economy. In any event, in the practice of contemporary project analysis the size of these gains or losses is generally assumed to be insignificant, and no provision is made for them in the analysis.

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. One way to avoid some of these problems is to treat a group of closely related investments as a single project. For example, it is common to consider the output of irrigation projects as the increased farm production, since valuing irrigation water is difficult. Another example is found in development roads built into inaccessible areas. It is argued that the production arising from the induced investment activities of otherwise unemployed new settlers should be considered a secondary benefit of the road investment. One way of avoiding the problem is to view this case as a land settlement project in which the road is a component. New production is then properly included among the direct benefits of the project and can be included in the project accounts at market or shadow prices, and no attempt need be made to allocate the benefits between road investment and the other kinds of investment that must be made by settlers and government if settlement is to succeed.

Another group of secondary costs and benefits has been called "technological spillover" or "technological externalities." Adverse ecological effects are a common example, and the side effects of irrigation development are often cited as an illustration. A dam may reduce river flow and lead to increased costs for dredging downstream. New tubewell development may have adverse effects on the flow of existing wells. Irrigation development may reduce the catch of fish or may lead to the spread of schistosomiasis. When these technological externalities are significant and can be identified and valued, they should be treated as a direct cost of the project (as might be the case for reduced fish catches), or the cost of avoiding them should be included among the project costs (as would be the case for increased dredging or for investment to avoid pollution).

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 that is characteristic. Thus, there is little likelihood of excess capacity giving rise to additional benefits through the multiplier. In any event, most of the multiplier effect is accounted for if we shadow-price at opportunity cost. Since the opportunity cost of using excess capacity is only the cost of the raw materials and labor involved, only variable costs will enter the project accounts until existing excess capacity is used up.

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.

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, national integration, or even national defense. Such intangible benefits are real and reflect true values. They do not, however, lend themselves to valuation. How does one derive a figure for the long-term value of a child's life saved, or for the increased comfort of a population spared preventable, debilitating disease? Benefits of this kind may require a modification of the normal benefit-cost analysis to a least-cost type of analysis, a topic we will take up when we discuss 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. For example, how many children will enroll in new schools? How many homes will benefit from a better system of water supply? How many infants will be saved because of more rural clinics?

In most cases of intangible benefits arising from an agricultural project, the costs are tangible enough: construction costs for schools, salaries for nurses in a public health system, pipes for rural water supplies, and the like. Intangible costs, however, do exist in projects. Such costs might be incurred if new projects disrupt traditional patterns of family life, if development leads to increased pollution, if the ecological balance is upset, or if scenic values are lost. Again, although valuation is impossible, intangible costs should be carefully identified and if possible quantified. In the end, every project decision will have to take intangible factors into account through a subjective evaluation because intangible costs can be significant and because intangible benefits can make an important contribution to many of the objectives of rural development.

3. PRICING PROJECT COSTS AND BENEFITS

Once costs and benefits have been identified, if they are to be compared they must be valued. Since the only practical way to compare differing goods and services directly is to give each a money value, we must find the proper prices for the costs and benefits in our analysis.

Prices Reflect Value

Underlying all financial and economic analysis is an assumption that prices reflect value-or can be adjusted to do so. In this chapter we will discuss how to find these prices. Before proceeding, however, it is necessary to define two economic concepts crucial to project analysis: marginal value product and opportunity cost.

Consider a Filipino farmer who applies nitrogenous fertilizer to his rice. In the 1979-80 season this fertilizer cost him P3.98 per kilogram of elemental nitrogen (N), and he received P1.050 for every kilogram of paddy rice he sold. (The symbol for Philippine pesos is P.) Table 3-1 shows the responsiveness of his rice to fertilizer. At low levels of application, fertilizer has a great effect on rice yield. Increasing the application from no fertilizer to 10 kilograms of elemental nitrogen increased the farmer's

Table 3-1. Crop Response to Nitrogen Fertilizer in the Philippines

	Paddy rice			**Shelled maize**		
Nitrogen (kgs/ha)	Yield (kgs/ha)	Value	MVP	Yield (kgs/ha)	Value	MVP
0	3,442	3,614		2,600	2,688	
10	3,723	3,909	29.50	2,830	2,926	23.80
20	3,971	4,170	26.10	3,040	3,143	21.70
30	4,187	4,396	22.60	3,230	3,340	19.70
40	4,370	4,588	19.20	3,400	3,516	17.60
50	4,520	4,746	15.80	3,550	3,671	15.50
60	4,637	4,869	12.30	3,680	3,805	13.40
70	4,721	4,957	8.80	3,790	3,919	11.40
80	4,772	5,011	5.40	3,880	4,012	9.30
90	4,791	5,031	2.00	3,950	4,084	7.20
100	4,777	5,016	-1.50	4,000	4,136	5.20
110				4,030	4,167	3.10

Table 3-1. Crop Response to Nitrogen Fertilizer in the Philippines

	Paddy rice			Shelled maize		
120				4,040	4,177	1.00
130				4,030	4,167	-1.00

Personal communication from Pedro R. Sandoval, University of the Philippines at Los Banos, September 1980. Rice responses are based on Changes in Rice Farming in Selected Areas of Asia (Manila: International Rice Research Institute, 1978), p. 61. Maize responses are based on University of the Philippines at Los Banos Experiment Station records. Prices are from the Bureau of Agricultural Economics, Ministry of Agriculture, Republic of the Philippines.

a. The farm-gate price of elemental nitrogen (N) in 1979-80 was F3.98 per kilogram
b. The farmgate price of paddy rice in 1979-80 was F1.050 per kilogram.
c. The marginal value product is the extra revenue that comes from increasing the quantity of an input used by one unit, all other quantities remaining constant. In this instance, the marginal value product is the increased value of paddy rice or shelled maize from using 1 additional kilogram of elemental nitrogen. Note that in this table the interval between levels of elemental nitrogen is 10 kilograms. Thus, the marginal value product of elemental nitrogen applied to rice between the 60- and 70-kilogram levels of application is the difference in value of output between the two levels divided by 10, or P8.80 [(4,957 - 4,869) - 10 = 8.80].
d. The farm-gate price of shelled yellow maize in 1979-80 was P1.034 per kilogram.
e. Beyond application of 100 kilograms of elemental nitrogen, all marginal value products for paddy rice are negative; therefore, figures for these applications of nitrogen to rice are not reported.

yield from 3,442 kilograms to 3,723 kilograms per hectare and increased the value of his output by P295, from P3,614 to P3,909. Thus, for every additional kilogram of elemental nitrogen the farmer applied at this level, he received P29.50 in return [(3,909 - 3,614) _ 10 = 29.50]. The extra revenue from increasing the quantity of an input used, all other quantities remaining constant, is the marginal value product of the input. In this case, then, the marginal value product of a kilogram of fertilizer is P29.50.

If the farmer could buy fertilizer for P3.98 a kilogram and use it to increase output by PP9.50, it obviously would have paid him to apply more. But as the intensity of application increases, each additional kilogram of fertilizer has less and less effect on production. If the farmer had increased his application from 80 to 90 kilograms per hectare, he would have increased the value of his production by only P20, from P5,011 to P5,031, and the marginal value product of a kilogram of fertilizer would have fallen to only P2.00 [(5,031 - 5,011) - 10 = 2.00]. Since he would have had to pay P3.98 per kilogram, it clearly would not have been worthwhile to apply fertilizer at this rate. In fact, it would only have paid the farmer to apply fertilizer up to the rate at which the marginal value product just equaled the price. For this Filipino farmer, it would have paid him to apply approximately 80 kilograms of nitrogen: between 70 and 80 kilograms the marginal value product of each additional kilogram was some P5.40, whereas between 80 and 90 kilograms it fell to P2.00. Thus, the farmer would have expanded his fertilizer use until he reduced the marginal value product of the fertilizer to its market price, and the market price, therefore, is an estimate of the marginal value product of the fertilizer.

The optimal amount of fertilizer to use will change, of course, when the price of fertilizer changes relative to the price of rice. If the relative price of fertilizer were to rise, the farmer would respond by reducing the amount of fertilizer he applies, increasing the marginal value product of the fertilizer (but reducing the total amount and value of production) until the marginal value product of the fertilizer again just equals its price. Suppose fertilizer were to double in price to P8.00 per kilogram of elemental nitrogen, and rice prices remained unchanged. Then, table 3-1 indicates the farmer should reduce the amount of fertilizer applied to a hectare from 80 kilograms to 70 kilograms, since between 60 and 70 kilograms the marginal value product was some P8.80 but between 70 and 80 kilograms it was only some P5.40.

In practice, because of risk and limited resources, the farmer would probably not have applied the amounts indicated here. We may consider that the farmer reduces his expected return by some "risk discount." Even so, the principle we are illustrating remains the same: the farmer equates the expected marginal value product less some risk discount to the price of fertilizer.

If this farmer also grew maize, for which in 1979-80 he would have received P1.034 per kilogram of shelled grain, table 3-1 indicates it would have paid him (in the absence of risk) to apply some 100 kilograms of elemental nitrogen to each hectare, because between 90 and 100 kilograms the marginal value product of a kilogram of nitrogen applied to maize was P5.20, whereas between 100 and 110 kilograms the marginal value product fell to P3.10, below the price of fertilizer.

Now, suppose the farmer had limited resources and could not obtain sufficient credit to increase his fertilizer application on both rice and maize to where the marginal value product equaled the price. Suppose the farmer had only 2 hectares, 1 planted in rice and 1 in maize, and resources sufficient to purchase just 80 kilograms of nitrogen. How should he have used it? Should he have put it all on rice and none on maize? If he did, he would have applied fertilizer to his rice at the level where the marginal value product was just about equal to its market price. But suppose he had shifted some fertilizer, instead, to maize. If he had shifted 10 kilograms, he would have reduced the value of his rice production by P54- from P5,011 to P4,957, or by P5.40 for each kilogram shifted-but he could have obtained some P238 for the 10 kilograms applied to maize, since the marginal value product between 0 and 10 kilograms was some P23.80 per kilogram. In other words, at these levels each kilogram of nitrogen shifted would reduce the rice value by P5.40 but increase the value of maize output by some P23.80. In the language of economics, the opportunity cost of fertilizer shifted from rice to maize was P5.40. Opportunity cost, thus, is the benefit forgone by using a scarce resource for one purpose-in this case applying fertilizer to maize-instead of for its best alternative use-in this case using the fertilizer to produce rice. Said another way, the opportunity cost is the return a resource can bring in its next best alternative use. What would be the opportunity cost if the farmer were to move a kilogram of fertilizer in the other direction, back from maize to rice? He would have given up P23.80 to gain only P5.40-not a very attractive proposition-and the opportunity cost, obviously, would be some P23.80.

Given his limited resources, it would pay the farmer to shift fertilizer from rice to maize until the marginal value product of fertilizer applied to both crops is the same. In the case of the Filipino farmer who could buy only 80 kilograms of fertilizer, if on the one hand he were to move 40 kilograms to maize, reducing his application on rice from 80 kilograms to 40 kilograms, he would have increased the marginal value product of the fertilizer on his rice to some P15. On the other hand, the 40 kilograms shifted away from rice and put on maize would have decreased the marginal value product of nitrogen applied to maize also to about P15. At these levels, there would be no advantage in shifting fertilizer between the two crops-the opportunity cost of shifting more fertilizer from rice to maize would be about P15, but the gain would also be only about P15-and the farmer would have reached the optimal level of application to both crops.

Note, however, that if the farmer could somehow have bought as much fertilizer as he wanted at the market price of P3.98 per kilogram-perhaps through a credit program-then the market price of fertilizer would have become its opportunity cost, and (in the absence of a risk discount) he should have increased his application to 80 kilograms on rice and 100 kilograms on maize.

From a single farmer to the economy as a whole, the same principles apply. In a "perfect" market-one that is highly competitive, with many buyers and sellers, all of whom have perfect knowledge about the market-every economic commodity would be priced at its marginal value product, since every farmer will have expanded his fertilizer use to where its marginal value product equals its price, and the same will have happened for every other item in the economy. That is, the price of every good and service would exactly equal the value that the last unit utilized contributes to production, or the value in use of the item for consumption would exactly balance the value it could contribute to additional production. If a unit of goods or services could produce more or bring greater satisfaction in some activity other than its present use, someone would have been willing to bid up its price, and it would have been attracted to the new use. When this price system is in "equilibrium," the marginal value product, the opportunity cost, and the price will all be equal. Resources will then have been allocated through the price mechanism so that the last unit of every good and service in the economy is in its most productive use or best consumption use. No transfer of resources could result in greater output or more satisfaction.

Without moving further into price theory, we can consider some direct implications for agricultural projects of the assumption that prices reflect value.

First, as everyone knows, markets are not perfect and are never in complete equilibrium. Hence, prices may reflect values only imperfectly. Even so, there is a great deal of truth in this price theory based on the model of perfect markets. In general, the best approximation of the "true value" of a good or service that is fairly widely bought and sold is its market price. Somebody in the economy is willing to pay this price. One can presume that this buyer will use the item to increase output by at least as much as its price, or that he is willing to exchange something of value equal to the price to gain the satisfaction of consuming the item. Hence, the market price of an item is normally the best estimate of its marginal value product and of its opportunity cost, and most often it will be the best price to use in valuing either a cost or a benefit. In financial analysis, as we have noted, the market price is always used. But in economic analysis some other price-a "shadow price"-may be a better indicator of the value of a good or service; that is, a better estimate of its true opportunity cost to the economy. When prices other than market prices are used in economic analysis, however, the burden of proof is on the analyst.

Finding 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 economist.

To find prices, the analyst must go into the market. 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." If the point of first sale is in a relatively competitive market, then the price at which the commodity is sold in this market is probably a relatively good estimate of its value in economic as well as financial terms. If the market is not reasonably competitive, in economic analysis the financial price may have to be adjusted better to reflect the opportunity cost or value in use of the commodity.

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. The increased value added of the product as it is processed and delivered to a market arises as a payment for marketing services. This value added is not properly attributed to the investment to produce the commodity. Rather, it arises from the labor and capital engaged in the marketing service. Usually the price at point of first sale can be accepted as the farm-gate price; even if this point is in a nearby village market, the farmer sells his output there and thus earns for himself any fee that might be involved in transporting the commodity from the farm to the point of first sale. But if any new equipment is necessary to enable the farmer to do this-say, a new bullock cart or a new truck-then that new equipment must be shown as a cost incurred to realize the marketing benefit in the project.

In projects producing commodities for well-organized markets, the farm-gate price may not be too difficult to determine. This would be true for most food grains traded domestically in substantial quantities. One may think of wheat in most countries of the Middle East and South Asia, of rice in South and Southeast Asia, and of maize in much of Latin America. It would also be true of farm products for which the processor is generally the first buyer (such as fresh fruit bunches for palm oil in Malaysia or milk in Jamaica), where the price quoted to the farmer is the price on his farm, and the firm responsible for the marketing comes to the farm to pick up the product.

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 not properly attributable to the investment in the project itself. This may happen, for instance, when the only price series available for a product records the prices at which it has been sold in a central market-such as the price for eggs in Madras, for melons in Tehran, or for vegetables in Bogota. In that case, the project analyst will have to dig deeper to find out how to value the marketing services. Then he can adjust the central market price to reduce it to the farm-gate price.

The farm-gate price is generally 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. This is the case, for example, for manioc and cocoyam in Africa. On the one hand, some argue that the true value of the crop is overstated if the market price is used as a basis for valuation because such a small proportion of the product is actually sold. On the other hand, the same crop in different situations may not be so difficult to value. Manioc is sold extensively in Nigeria to make gari flour, and it is commonly traded in local markets in tropical Latin America and the Caribbean.

The farm-gate price may be a poor indicator of the true opportunity cost we want to use in economic analysis. In Ghana the Marketing Board takes some proportion of the cocoa price as a tax for development purposes. In Thailand, a rice "premium"-that is, a tax on rice exports-effectively keeps the domestic price well below what the international market would pay. In these cases, when the commodity is traded its economic value would have to be considered higher than the actual farm-gate price, and this price distortion will have to be corrected in the economic analysis. In other cases, just the opposite happens. In Mexico the price of maize is maintained at a high level to transfer income to ejidatarios, the small farmers. In Malaysia, the price of rice is supported above world market levels to encourage local production and to reduce imports. In these cases, part of the price does not really reflect the economic value of the product-its cost if it could be imported-but rather an indirect income transfer to small farmers. Again, this price distortion will have to be corrected in the economic analysis.

Pricing intermediate goods

By emphasizing 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 on 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 marketing structures. In some countries it would hardly make sense in an egg production project to value the pullets produced in a pullet production enterprise and then "sell" these pullets to the egg production enterprise on the same farm. But in other countries there might be an active market in pullets, which would mean that we could expect to find a reasonably competitive price to use in the economic analysis. 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, 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, 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.

Other problems in finding market prices

Considerable confusion often arises in determining the values for two important inputs in agricultural projects, land and labor. This happens primarily when the analysis moves from the financial project accounts to the economic analysis (to which we will turn in chapter 7). In the accounts prepared for the financial analysis, the treatment of prices for land and labor is quite straightforward: the price used is the price actually paid. Thus, if the farmers in a settlement project are expected to pay the project authority a price for the land they acquire, perhaps through a series of installments, then the actual price in the year it is paid is entered in the project accounts. In the financial analysis, we do not question whether this is a "good" price in economic terms. Similarly, if land must be bought for the right-of-way for canals in an irrigation project, the actual price to be paid is entered in the project accounts in the financial analysis. Or, if the project includes tenant farmers who will receive help in increasing wheat production, then in the financial accounts for these tenant farmers the analyst will enter the rent paid each year at the amount actually paid, or at the farm-gate value of the wheat delivered to the landowner if the tenants pay rent in kind.

If farm accounts are laid out on a with-and-without basis following the format suggested in chapter 4, in those instances where the project involves only changing the cropping pattern (say, a shift from pasture to irrigated sorghum), the cost of the land (in this instance an opportunity cost) need not be separately entered because of the form of the account. When the net benefit without the project is subtracted from the net benefit with the project, the contribution of the land to the old cropping pattern is also subtracted and only the incremental value remains.

In valuing labor for the financial analysis accounts, again, the problems arise when the financial accounts are adjusted to reflect economic values. For financial analysis, the analyst enters the amounts actually paid to hired labor, either in wages or in kind, in the farm budgets or project accounts. Family labor is treated differently. It is not entered as a cost; instead, the "wages" for the family become a part of the net benefit. Thus, if our project increases the net benefit, it also in effect increases the family's income or "wages" for its labor. Again, if we follow the format suggested in chapter 4, the account will automatically value the family labor at its opportunity cost, and the incremental net benefit will reflect any increased return the family may receive for its labor.

Prices for agricultural commodities generally are subject to substantial seasonal fluctuation. If this is the case, some decision must be made about the point in the seasonal cycle at which to choose the price to be used for the analysis. A good starting point is the farm-gate price at the peak of the harvest season. This is probably close to the lowest price in the cycle. The line of reasoning here is that as prices rise during the cycle at least some part of that rise is a result not of the production activities of the farmer but of the marketing services embodied in storing the crop until consumers want it. But, markets being what they are, there may be an element of imperfection in the harvest price level. Market channels may become so glutted that merchants try actively to discourage farmers from immediately bringing their crop to the market by offering a price that even the merchants themselves would admit is too low. Even so, the need to sell immediately to meet debt obligations may force farmers to offer their crops despite these artificially low, penalty prices. In some cases, therefore, a price higher than the farm-gate price in the harvest season may be selected. But there is an obligation here to justify the price chosen as more valid than the lowest seasonal price. One way to resolve this problem may be to include an element of credit in the project design. This would permit farmers to withhold their product from the market until prices have had a chance to rise from their seasonal lows but at the same time to have enough money to meet their cash obligations and family living expenses. The credit element may also include credit for building on-farm storage so that farmers will have a safe place to store their production until they decide to market it at a better price.

Prices vary among grades of product, of course, and picking the proper price for project analysis may involve making some decisions about quality of the product. In general, it can be assumed that farmers will produce in the future much the same quality as they have in the past and will market their product ungraded. In many agricultural projects, however, one objective is to upgrade the quality of production as well as to increase the total output. Small dairy farmers, for instance, may be able with the help of the project investment to meet the sanitation standards of the fluid milk market and to command a higher price; or reduced time for delivery may hold down sucrose inversion in sugarcane; or better pruning will increase the average size of the oranges Moroccan farmers can offer European buyers. In such cases, the proper price to select is the average price expected for the quality to be produced.

A special problem occurs in pricing housing. If project investment includes housing construction, as would be the case for a settlement project, then one benefit arising from the investment is the rental value of the house. Since the rental value will usually be an imputed value rather than a real market price, care must be exercised in determining it. No more should be allowed for the rental value than would normally be paid by a prospective tenant family. Nor should more rental value be allowed than the family would be expected to pay for a comparable house in the vicinity or in a similar area elsewhere (if the new settlement is in a distant locale). In particular, the temptation should be avoided to take as a rental value some arbitrary proportion of the housing cost. Otherwise, overly elaborated housing construction might be justified simply by assigning it an unrealistically high imputed value.

Project boundary price

Prices used in analyzing 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. Many projects have a marketing component, perhaps because there is no competitive channel reaching down to the farm-gate level for the unprocessed product. Of concern in these projects are both the farm-gate price (on which to base the estimates of the net benefit to the farmer) and the price at which the processed product is sold in the market (after being handled in the facilities financed by the project). Such a case is found in the Rahad project in the Sudan. There the Roseires dam on the Blue Nile will provide irrigation water for the production of cotton, which will be ginned in new facilities financed by the project. The analyst, of course, is interested in the price of cotton paid to the farmers so that their incomes can be estimated. But, since this price is set administratively, it could not be used directly in the economic analysis of the project. The analyst is also interested in the price of ginned cotton because that is the first product the project will actually sell in a reasonably competitive market. In this case, the point of first sale is f.o.b. (free on board) Port Sudan, and the price there becomes the basis for the benefit stream.

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 judgment, not mechanics. No esoteric mathematical model exists to come to the aid of the project analyst; like everyone else he must take into consideration all the facts he can find, seek judgments from those he respects, and then come to a conclusion himself. It tends to be a rather unsettling process. The only consolation is that careful, considered judgment about the course of future prices is better than giving the matter no thought at all and wasting scarce resources on incompletely planned projects.

We have been discussing how to find market prices, and it is from these current prices that we begin. 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? Not easy questions to deal with, but some approaches to answers can be made. In financial analysis, of course, a change in a relative price means a change in the market price structure that producers face either for inputs or for outputs. A change in a relative price, then, is reflected directly in the project's financial accounts. A rise in the relative price of fertilizer reduces the incremental net benefit-the amount the farm family has to live on. It is thus clearly a cost in the farm account. The same line of reasoning can be applied in the financial analysis for any other group participating in the project.

A change in the relative price of an item implies a change in its marginal productivity-that is, a change in its marginal value product-or a change in the satisfaction it contributes when it is consumed. In economic analysis, where maximizing national income is the objective, a change in the relative price of an input implies a change in the amount that must be forgone by using the item in the project instead of elsewhere in the economy; it is therefore a change in the contribution the output of the project makes to the national income. Thus, changes in relative prices have a real effect on the project objective and must be reflected in project accounts in the years when such changes are expected.

There are several kinds of commodities subject to future changes in relative prices. Most agricultural project analysts would probably agree that the relative price of energy-intensive agricultural inputs is likely to continue to rise over the next several years, just as it has done over the past few years. Thus, on the input side the project accounts might show an annual increase, at least for the first decade or so, in the cost of fuel for tractors, for transporting the harvested crop, for drying grain, and for such petroleum-based inputs as fertilizers and chemical pesticides. On the output side, there may be some commodities that will probably continue to be in short supply and whose prices will rise as incomes increase-one might think of mutton from fat-tailed sheep in Iran, or, for that matter, of most meat products worldwide. How much will prices increase relative to those of other products? Certainly a difficult question, but one the project analyst must confront. For a range of products-from industrial crops such as fibers or oilseeds to food grains and vegetables-judgments will have to be made on the best possible basis.

In some countries, relative wages of rural labor may rise as economic development proceeds during the life of a project. This will have implications not only for the prices assumed for hired labor, but also for the incentive effect exerted by a given change in net benefit and for the technology assumed as a basis for projections in the farm budgets and project accounts.

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. The analyst then need only adjust future price estimates for anticipated relative changes, not for any change in the general price level. By comparing these estimates of costs and benefits with the constant prices, he is able to judge the effects of the project on the incomes of participants and its income-generating potential for the society as a whole. 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 the measures of project worth discussed in chapter 9 may be applied directly. 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.

It is quite possible, however, to work the whole project analysis in current prices. This has the advantage that all costs and benefits shown would be estimates of what the real prices will be in each year of the project. Furthermore, estimates of investment costs will be in current terms for the year in which they are expected to occur, so that the finance ministry can more easily anticipate these needs and budget the amounts necessary to finance the project on schedule. The problem in this approach is that it involves predicting inflation rates. For items to be imported, some help is available in the World Bank report on Price Prospects for Major Primary Commodities (1982a), which is published biennially and updated in six-month intervals and includes an estimate of inflation in developed countries. For domestic inflation rates in developing countries, other sources will have to be consulted, but obtaining an estimate in which one can place even minimal confidence will be difficult, to say the least. Even casting the project analysis in current terms may raise problems for the project analyst. Many governments have policy goals that call for greatly reduced inflation, and they cannot permit the circulation of official documents that assume rapid inflation will continue.

The mere mechanics of using current prices presents no analytical problem in project analysis, although it does complicate the computations. When we consider measures of project worth, some means of deflating future prices must be adopted for comparing future cost and benefit streams in terms that are free from the effects of general price increases. We will illustrate the methodology in chapter 10 in the section "Calculating Measures of Project Worth Using Current Prices."

Even when constant prices are used in the more conventional approach to project analysis, a table estimating the budgetary effects of the project in current terms that will prevail at least during the investment phase should be included either in the analysis or as a separate memorandum. It would list in current prices domestic currency needs, foreign exchange requirements, and subsidies. The finance ministry would then have better estimates to work with, and delays because of budgetary shortfalls could more easily be avoided.

Prices 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. In many countries where agricultural exports are important, there are groups in the agriculture ministry or the finance ministry whose help may be sought.

There are also several international organizations and trade groups to which the analyst may turn. The World Bank, for instance, publishes its projections under the title Price Prospects forMajorPrimary Commodities. The Food and Agriculture Organization (FAO) sponsors intergovernmental groups that publish price information on rice; grains (other than rice); citrus; hard fibers; fibers (other than hard fibers); oilseeds, oils and fats; bananas; wine and wine products; tea; meat; and cocoa. Information may be obtained from the secretary of the relevant intergovernmental group at the FAo headquarters in Rome or from the FAo representative in individual countries.

Several international commodity organizations keep detailed price information for the products of their interest. These include the International Tea Committee, the International Cocoa Organization, the International Wool Secretariat, the International Coffee Organization, the International Association of Seed Crushers, the International Rubber Study Group, and the International Sugar Organization, all with headquarters in London; the International Olive Oil Council in Madrid; and the International Cotton Advisory Committee in Washington.

Some individual nations systematically collect production and price information for crops and livestock products of interest to them, and they often are willing to share this information with analysts in other countries without charge or restriction. The United States Department of Agriculture-probably the most important of these-publishes detailed studies about most major crops traded in international markets. Information may be obtained from agricultural attaches in American embassies, or directly from the department's Foreign Agriculture Service. The Commonwealth Secretariat in London publishes information about price trends for commodities of interest to its member nations. A detailed list of "Sources of Information on World Prices" is available from the World Bank (Woo 1982).

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 organization. Also, in financial analysis, if the farm-gate price is set administratively and is not allowed to adjust freely to world 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 involve deriving a shadow price based on international prices. In such instances it is necessary to calculate export or import parity prices. (See chapter 7, the subsection "Economic export and import parity values.") These are the estimated prices at the farm gate or project boundary, which are derived by adjusting the c.i.f. (cost, insurance, and freight) or f.o.b. prices by all the relevant charges between the farm gate and the project boundary and the point where the c.i.f. or f.o.b. price is quoted. The elements commonly included in c.i.f. and f.o.b. are given in table 3-2.

Table 3-2. Elements of C.i.f. (Cost, Insurance, Freight) and F.o.b. (Free on Board)

Item	Element
C.i.f.	*Includes:*

Table 3-2. Elements of C.i.f. (Cost, Insurance, Freight) and F.o.b. (Free on Board)

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

Source: William A. Ward, “Calculating Import and Export Parity Prices,” training materials of the Economic Development Institute, CN-3 (Washington, D.C.: World Bank, 1977), p.8.

One common case for which an export parity price has to be calculated is that of a commodity produced for a foreign market. Table 3-3 gives an example based on the Rahad project in the Sudan. It shows the generalized elements for calculating export parity prices so that the same methodology can be applied in other cases. As noted earlier, the Rahad project included cotton gins. Since the gins produce lint and cottonseed for export and scarto, a by-product of very short fibers not suitable for export and sold locally, the analyst needed three prices. For the lint and seed estimates, he began with forecasts of the 1980 c.i.f. prices in current terms at Liverpool, which were available from World Bank publications. From these c.i.f. prices, he then deoucted insurance, ocean freight, export duties, port handling costs, and rail freight from the cotton gin at the project site to Port Sudan, thus obtaining the export parity prices at the project boundary: LSd 178.650 for lint and LSd18.097 for seed. (The symbol for Sudanese pounds is LSd.) The price for scarto, which was not exported, was based on the prevailing domestic price.

To illustrate, we may continue to calculate the export parity price at the farm gate, although in the Rahad example, where the farm-gate price was set administratively, this calculation was not made. The computations are laid out in the part of table 3-3 that continues from the entry for "Equals export parity price at project boundary." Here a new issue arises. The three products that the gin produces-lint, seed, and scarto-must be converted into their seed cotton equivalents, since it is seed cotton that the farmer sells. Similar conversions have to be made in many other instances-for example,

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Table 3-3. Financial Export Parity Price for Cotton, Rahad Irrigation Project, Sudan (1980 forecast prices)

Step in the calculation	Relevant step in the Sudanese example	Value per ton		
		Lint	**Seed**	**Scarto**
C.i.f. at point of import	C.i.f. Liverpool (taken as estimate for all European ports)	US$639.33	US$103.39	
Deduct unloading at point of import *Deduct* freight to point of import *Deduct* insurance	Freight and insurance F.o.b. Port Sudan	39.63	24.73	
Equals f.o.b. at point of export	F.o.b. Port Sudan	US 599.70	US$ 78.66	
Convert foreign currency to domestic currency at official exchange rate	Converted at official exchange rate of LSd 1.000=US$2.872	LSd 208.809	LSd 27.389	
Deduct tariffs	Export duties	17.813	1.000	
Add subsidies	(None)			
Deduct local port charges	Port handling cost Lint: LSd 5.564 per ton Seed: LSd 1.510 per ton	5.564	1.510	
Deduct local transport and marketing costs from project to point of export (if not part of the project cost)	Freight to Port Sudan at LSd 6.782 per ton	6.782	6.782	
Equals export parity price at project boundary	Export parity price at gin at project site	LSd 178.650	LSd 18.097	
Conversion allowance (if necessary)	Convert ot seed cotton (LSd 178.650 x 0.4 + LSd 18.097 x 0.59 + LSd 110.200 x 0.01)	71.460	10.677	1.102
Deduct local storage, transport, and marketing costs (if not part of project cost)	Ginning, baling, and storage (LSd 15.229 per ton)		15.229	
	Collection and internal transfer (LSd 1.064 per ton)		1.064	

Table 3-3. Financial Export Parity Price for Cotton, Rahad Irrigation Project, Sudan (1980 forecast prices)

Step in the calculation	Relevant step in the Sudanese example	Value per ton
Equals export parity price at farm gate	Export parity price at the farm gate	LSd 66.946

LSd Sudanese pounds. US$ U.S. dollars
Source: Adapted from World Bank, "Appraisal of the Rahad Irrigation Project," PA-139b (Washington, D.C., 1973; restricted circulaton) annex 16, table 6. The format of the table is adapted from Ward, "Calculating Import and Export Parity Prices," p.9
a. Scarto is a by-product of very short, soiled fibers not suitable for export and is sold locally at a price of LSd 110.200 per ton.
b. Seedcotton is converted into lint, seed, and scarto assuming 1 ton of seed cotton yields 400 kilograms seed, and 10 kilograms scarto.

rice milling or groundnut decortication. For the Rahad project, a weighted price of LSd83.239 forthe seed cotton was calculated using a ginning outturn of 40 percent lint, 59 percent seed, and 1 percent scarto. From this weighted price were deducted the ginning, baling, and storage charges and the costs of collection and transport from the farm gate to the gin, thus arriving at the farm-gate export parity price of LSd66.946.

A parallel computation leads to the import parity price. Here the issue is the price at which an import substitute can be sold domestically if it must compete with imports. Table 3-4 illustrates this issue with the example of maize production in Nigeria. The same example is presented diagrammatically in figure 3-1. Nigeria is a net maize importer, and the project is to produce maize for domestic consumption to replace imported maize.

Table 3-4. Financial Import Parity Price of Early-crop Maize, Central Agricultural Development Projects, Nigeria

Steps in the calculation	Relevant steps in the Nigerian example	Value per ton
F.o.b. at point of export	F.o.b. U.S. Gulf ports, No. 2 U.S. yellow corn in bulk	US$116
	Freight and insurance	31
Add freight to point of import *Add* unloading at point of import *Add* insurance *Equals* c.i.f. at point of import	C.i.f. Lagos or Apapa	US$147
Convert foreign currency to domestic currency at official exchange rate *Add* tariffs *Deduct* subsidies *Add* local port charges	Converted at official exchange rate of N1 = US$1.62 none none Landing and port charges (including the cost of bags)	N91 22

Table 3-4. Financial Import Parity Price of Early-crop Maize, Central Agricultural Development Projects, Nigeria

Steps in the calculation	Relevant steps in the Nigerian example	Value per ton
Add local transport and marketing costs to relevant markets	Transport (based on a 350-kilometer average)	18
Equals price at market	Wholesale price	N 131
Conversion allowance if necessary	(Not necessary)	
Deduct transport and marketing costs to relevant market	Primary marketing (includes assembly, cost of bags, and intermediary margins)	-14
	Transport (based on a 350-kilometer average)	- 18
Deduct local storage, transport, and marketing costs (if not part of the project costs)	Storage loss (10 percent of harvested weight	- 9
Equals import parity price at farm gate	Imported parity price at farm gate	N 90

N = Nigerian naira

Source: Adapted from World Bank, "Supplementary Annexes to Central Agricultural Development Projects," 1370-UNI (Washington, D.C., 1976; restricted circulsation), supplement 11, appendix 2, table 4. The format of the table is adpated from Ward, "Calculating Import and Export Parity Prices," p. 10.

a. Forecast from World Bank, Price Prospects for Major Primary commodities, 814/76 (Washington, D.C., 1976), annex 1, p. 12.

We begin with the f.o.b. price at the point of export-in this case U.S. ports on the Gulf of Mexico-derived from World Bank commodity estimates. To this we add freight and insurance to obtain the c.i.f. price at either Lagos or Apapa, the two Nigerian ports concerned. Then we would add any tariffs and subsidies (in this case there are none); add local port charges for harbor dues, fumigation, handling, and the like; and add local transport to the relevant inland market. The result is the wholesale price of imported maize. It is this wholesale price of maize in the inland market that is the focal point of our calculation. The alternative to project production is not to import the maize and transport it to the project area. Rather, the alternative is to import it and market it directly on the inland market. Thus the price the farmer can expect to receive in the absence of tariffs, subsidies, or an import ban is the wholesale price less the cost of moving his maize to the market. If the project had included processing facilities, then the relevant project boundary price would have been this wholesale price less handling costs from the processing facility to the wholesale market. In the Nigerian project, no processing facilities were included, so the relevant import parity price is the farm-gate price. As we move back from the wholesale market to the farm gate, we would have to provide for any conversion allowance. In this case none is necessary, since it is assumed that the farmer will sell shelled maize. From the wholesale price, then, we deduct local marketing costs including assembly, bags, and intermediary margins, transport from the farm to the market, and storage losses, thus obtaining the import parity price at the farm gate of N90. (The symbol for Nigerian naira is N.) This is the maximum price the farmer could expect to receive, again in the absence of tariffs, subsidies, or an import ban.

4. FARM INVESTMENT ANALYSIS

Once market prices have been determined for those items that enter the cost and benefit streams, this information must be arranged in "pattern" accounts to begin the assessment of the effects a proposed project will have on the farmers, public and private enterprises, and government agencies that will participate in project implementation. These accounts are central to the financial analysis of agricultural projects; they are always based on market prices.

Although we will touch on the essential elements of financial analysis, much more could be taken up here. Just how elaborate the financial analysis must be for a particular project will depend on the complexity of the project. Most agricultural projects will call for a financial projection based on at least one pattern farm plan that is assumed for participating farmers. This pattern (or model) farm plan projects resource use and income flows for a group of similar farms participating in the project. The financial projections for the private and public firms or project entities may be quite summary in nature for a simply organized project, but a project in which several different firms and project entities are concerned or one that poses special financial problems may involve a much more complex analysis. The major accounts needed will be outlined in this chapter and in chapters 5 and 6, and pattern formats suggested. This will enable the project analyst to proceed with the confidence that he is preparing an acceptable financial analysis. For more complex projects, especially those projects involving more complex public or private firms with specialized cost, revenue, or financing situations, the project analyst will have to move beyond what is discussed here. Agricultural project analysts may want to turn for more technical help to financial analysts or accountants, just as they would turn to agriculturalists or livestock technicians for their particular expertise. Many financial analysts and accountants, however, will not be familiar with methodologies of agricultural project analysis or with the particular analytical needs of the financial aspects of these projects, so even financial analysts and accountants may find that the following discussion may help them respond to a request for assistance.

Objectives of Financial Analysis

Six major objectives for financial analysis occur in analyzing agricultural projects.

Assessment of financial impact

The most important objective of financial analysis is to assess the financial effects the project will have on farmers, public and private firms, government operating agencies, and any others who may be participating in it. This assessment is based on an analysis of each participant's current financial status and on a projection of his future financial performance as the project is implemented. Detailed financial projections are needed for this analysis.

Judgment of efficient resource use

The overall return of the project and the repayment of loans extended to individual enterprises are important indicators of the efficiency of resource use. For management especially, overall return is important because managers must work within the market price framework they face. Farm investment analysis and financial ratio analysis provide the tools for this review. Project analysts and others concerned with decisions on policies for national economic growth and development will have to look beyond the financial analysis-at market prices-and form a judgment about the effects of the project on real resources for the economy as a whole. In chapter 7 we take up this issue in the discussion of how to determine economic values.

Assessment of incentives

The financial analysis is of critical importance in assessing the incentives for farmers, managers, and owners (including governments) who

will participate in the project. Will farm families have an incremental income large enough to compensate them for the additional effort and risk they will incur? Will private sector firms earn a sufficient return on their equity investment and borrowed resources to justify making the investment the project requires? For semipublic enterprises, will the return be sufficient for the enterprises to maintain a self-financing capability and to meet the financial objectives set out by the society?

Provision of a sound financing plan

A principal objective of the financial analysis is to work out a plan that projects the financial situation and sources of funds of the various project participants and of the project itself. The financial plan provides a basis for determining the amount and timing of investment by farmers and for setting repayment terms and conditions for the credit extended to support the investment. It provides the same basis for an assessment of the investment plans and debt repayment capacities of public and private firms participating in the project. Finally, for the project as a whole, the financial plan is the basis for determining the amount and timing of outside financing-whether from the national treasury or from international sources-and for establishing how rapidly the borrowed resources should be repaid. The estimated effect of inflation on both revenues and costs should be taken into account in making this assessment.

Coordination of financial contributions

The financial plan allows the coordination of the financial contributions of the various project participants. The coordination is made on the basis of an overall financial projection for the project as a whole. It addresses itself to such questions as whether the availability of resources from the treasury or international agency is matched with farmers' investment capacities and available funds for investment and operating expenses as well as with the timing of expenditures for project investments such as feeder roads and irrigation structures and for working capital needed for stocks in processing industries and the like.

Assessment of financial management competence

On the basis of a projection of the pattern financial accounts, especially for the larger firms and project entities, the analyst can form a judgment about the complexity of the financial management the project will require and about the capability of those who will manage the project's implementation. And from this assessment, the analyst can then judge what changes in organization and management may be necessary if the project is to proceed on schedule and what specialized training may be advisable.

Table 4-l. Differences between Farm Income Analysis, Funds Flow Analysis, and Farm Investment Analysis

Item	Farm income analysis	Funds flow analysis	Farm investment analysis
General objective	Check currentperfor-mance of farm	Check farmer's liquid-ity	Check attractivenes-sof additional invest-ment
Period usually ana-lyzed	Individual years	Loan repayment period	Useful life of invest-ment
Prices used	Current prices	Current prices	Constant prices
Treatment of capital	Annual depreciation charge	Cash purchasesand sales	Initial investment, residual and sales
Off-farm income	Excluded	Cash portion included	Cash and noncash included
Home consumed farm production	Included	Excluded	Included
Performance criteria	Return to capital and labor engaged on farm	Cash available to farmfamily	Return to additional resources engaged
Time value	Undiscounted	Undiscounted	Discounted
Performance indica-tors	Profit as a percentageof net worth, family income	Cash surplus or deficit	Net present worth, internal rate of return, benefit-cost ratio,net benefit-investment ratio,net benefit increase

Source: Schaefer-Kehnert (1980).

a. Also called sources-and-uses-of-funds analysis.

b. Benefit-cost analysis of on-farm investments.

Preparing the Farm Investment Analysis

The starting point for both the financial and the economic analysis of an agricultural project is generally a group of investment analyses of pattern or model farms, based on budgets for individual pattern farms. These pattern farm budgets compare the situation with the project to that anticipated without the project for the duration of the project. They enable the analyst to form a sound judgment about the likely benefit to farmers of participating in an agricultural project and about the incentives for farmers to do so.

Farm investment analysis is the topic of this chapter. This analysis is similar to, and sometimes confused with, farm management analyses done by agricultural economists, which may be distinguished as farm income analysis and funds flow analysis. The differences are summarized in table 4-1.

Farm income analysis is generally used to evaluate the performance of a farm in a particular year. Its objective is to help improve the management of the farm. Current prices are used, and a depreciation allowance is included to account for that portion of longer-term capital investment used up in the year being considered. Noncash items such as home-consumed production and payments in kind are included. Off-farm income and expenditure are excluded because the analysis is intended to evaluate the performance only of the farm itself. The analysis provides an estimate of the return to capital invested and to the farmer's labor, and this may then be compared with the return to alternative cropping patterns or to off-farm opportunities.

Funds flow analysis, also called sources-and-uses-of-funds analysis, is used to determine a farmer's liquidity in an analysis of his credit situation. Only cash items, including purchase and sale of capital goods, enter the analysis. Off-farm cash income and expenditure are included, but home-consumed production is not. The analysis shows the cash available to the family over a period of time.

Farm investment analysis, in contrast, is undertaken to determine the attractiveness of a proposed investment to farmers and to other participants, including the society as a whole. It projects the effect on farm income of a particular investment and estimates the return to the capital engaged. It follows the principles of discounted cash flow analysis (discussed in detail in chapters 9 and 10). The analysis is projected over the useful life of the investment. The initial investment is shown at the beginning of the projection, and a residual value at the end. In general, the analysis is cast in constant prices, although allowance may have to be made for inflation. Off-farm income is included. Even though we use the term "cash flow," noncash elements enter the projection, including home-consumed production and payments and receipts in kind. (The term was first applied to industrial investments, in which noncash elements are less common.) When doing farm investment analysis, some elements of funds flow analysis are often incorporated to enable the analyst to assess the farmer's liquidity and his credit use. Those who wish to pursue farm income analysis or funds flow analysis in relation to project analysis may refer to standard farm management texts such as Harsh, Connor, and Schwab (1981) and Kay (1981). Those who want more detail about the application of farm budgets to project analysis may consult Brown (1979).

Pattern farm investment analysis that includes farm budgets should be prepared for almost every agricultural project. Although agricultural project analyses that do not have farm budgets are used, it is increasingly accepted that farm budgets are an extremely desirable, if not essential, part of project analysis. The benefit stream of an agricultural project may be built up simply by multiplying the total area to be planted by the expected yield, essentially treating the whole area as one undifferentiated farm. If this is all that is done, it may hide crucial information about the effects of the project on individual farmers and obscure underlying unrealistic assumptions. Even when the project involves only a public sector undertaking, a farm budget is likely to be necessary to test the feasibility of the cropping pattern and the financial viability of the enterprise.

The purpose in preparing farm investment analyses for a project is not to take a sample of the farms in the project area. Rather, it is to select major farm types expected to participate and to look at the impact of the project on them. These farm investment analyses are usually projections for the life of the project, often twenty to twenty-five years, not for just a single year. The analyst will want to examine the cropping pattern and perhaps to diagram it; to determine the labor that will be required if farmers are to participate in the project and perhaps to prepare a month-by-month labor budget showing requirements and the availability of family labor; to look at production and inputs; and, finally, to prepare a farm budget in the detail needed for understanding and evaluating the effects of the project on the income of participating farmers. From these, the analyst can assess the financial effect of the proposed project on typical farms-both to judge incentives for participation and to determine whether national policies on minimum incomes for project participants are being met.

Farm investment analyses and farm budgets can of course be prepared for farms of any size. The problems of analyses for smaller farms are the focus here, since many, if not most, agricultural projects in developing countries will be directed toward smallholders whose families consume a large part of the food they produce.

Large commercial farms and plantations, however, whether publicly or privately held, are more like other business enterprises than they are like small, family-operated farms. Projected accounts for these large agricultural undertakings are probably more appropriately cast in formal financial statements such as those of the agricultural processing industries discussed in chapter 5.

In considering small farms, the analyst will be particularly concerned with the effect of the project on the total income of the farm family. The aspects of the small farm as a family unit and as a business firm must be clearly understood and appreciated. These will differ from society to society, and the project analyst should either know the society well enough to anticipate the farmers' response or be advised by others who do. One must assess the attitude of the family to proposed cropping patterns that involve more days of labor, to patterns that increase cash crop output and reduce food crop production below household requirements, to patterns that change the work responsibilities of men and women, and to patterns that require the family to run a considerable market risk. Farmers are price responsive, of course; the extensive research has amply confirmed this (Krishna 1967). But farmers live in a particular cultural and risk environment, and project analysts must take this environment into account when they project their pattern farm investment analyses.

Backed by this understanding of the particular cultural environment, the analyst will prepare the farm investment analyses as realistically as possible to determine what the family gains by participating in the project. The projection must be based on a specific package of technological innovation. The effectiveness of the proposed new technology on small farms must be realistically assessed, and the technological assumptions must be checked to ensure that they reflect on-farm conditions and not those of an experiment station. The analyst must form a judgment about how rapidly farmers will be willing to adopt new practices. The farm investment analysis should confirm that adoption of a new technology will really be financially worthwhile, for farmers can respond to financial incentives only when it is truly remunerative for them to do so. The analyst must determine how much credit will stimulate farmers to adopt new practices and must assess how risky a new technology is and how variable the farm income may be under the project. The analyst will want to test the effect of risk on family income by determining what happens if yields fall below expectations or if prices are lower than anticipated and by undertaking similar sensitivity tests. Through such tests a margin to allow for bad years can be built into the farm plan.

Although in agricultural projects the analyst generally looks at budgets for entire farms, partial budgeting techniques can be used for undertakings that involve only a relatively minor change in the farm organization. To do this, one looks at the marginal cost (including opportunity cost) of adding a production activity and compares it with the marginal increase in benefit that the new activity will bring. Partial budgets are an effective tool for helping to search out the best combination of production activities. Brown (1979) discusses their use in some detail. In most projects, however, we expect rather substantial changes over a prolonged period, and under these circumstances it is better to project whole farm budgets. Then the total effect of the project on family income can be better assessed.

The information on which the project analyst will base his farm investment analysis will come from many sources. Project analysts will have to rely heavily on their professional colleagues to determine a sensible cropping pattern and livestock activity for a proposed project, the output that may be expected, the inputs that will be required, and the relevant prices for products. The project analyst will want to pay particular attention to the realism of the estimates provided by the agriculturalists and livestock specialists he consults. Unrealistic assumptions about yields, input levels, or rates of farmer acceptance and, hence, of buildup in project benefits will negate the best of project analyses.

The analyst will certainly want to visit the site of the proposed project and typical farms that will be included. Nothing substitutes for the firsthand knowledge that being there brings.

A crucial source of information in every agricultural project is the farmers themselves. Only through interviews with farmers can a project analyst reach a valid conclusion about the realism of his farm investment analysis. The project analyst will want to interview farmers about their present cropping patterns, labor requirements, use of inputs, and the market prices actually received and paid. He will want to gain a sense about the farmers' willingness to participate in the project were it to proceed. In a project area or on a similar site some farmers often are already using a proposed new technology. It is most important that these farmers be interviewed to tap their experience. The analyst will want to know the yields the farmers actually have realized with the new technology, the inputs they actually must employ, and their general comments on the new technology and cropping pattern proposed for the project. The analyst will want to assess the labor requirements farmers have found necessary to use the new technology.

Interviewing farmers is an art in itself, and only a few comments can be made here. The information farmers give will usually be contradictory, but out of a group of interviews the project analyst can gain a sense of feasible technological and financial relations. Farmers will have to be interviewed in the field, not in the office. The analyst will have to know the local measurements and not expect everything to be reported neatly on a unit basis. The analyst or one of his staff should probably conduct the interviews alone or with very few other people around. Great care should be taken to establish a good atmosphere in the interview so that farmers are not overawed by the analyst's presence; farmers should also know that the information they give will not be used for tax purposes. A formal questionnaire may be helpful, especially if much information is to be collected by assistants, but any questionnaire should be carefully pretested in the field before use. It may be better for the analyst or his assistants to fill in the questionnaire only after the interview is complete and the interviewer has left the farmer. In any event, before the interviews the analyst should have formed a clear idea about the information he needs, perhaps in the form of a list of questions, so that critical information will not be overlooked. Questions put to farmers should be as specific as possible. Most information gathered should relate to actual experience, perhaps in the last cropping season. Questions about hypothetical situations should be avoided to the extent possible. The very nature of seeking information about a proposed project will, however, of necessity involve many "what if" kinds of questions. Cropping patterns are usually based on the judgment of the agriculturalists and livestock specialists working with the project analyst. Their judgment, in turn, will be based on their familiarity with the agriculture of the area, on research results and the results of pilot projects-perhaps undertaken especially as part of the project preparation-and on their knowledge of the farmers who will participate in the project. In most instances, experienced technicians can propose realistic patterns close to the optimum, but sometimes linear programming may be used as a more formal methodology to optimize cropping patterns. Linear programming has been applied in preparing agricultural project analyses but is not regularly used either in national planning agencies or in international lending agencies. It is a complex methodology that requires more formal input-output data than does simple budgeting, and in practice it requires computers. There are serious methodological limitations to the use of linear programming for agricultural project analysis: problems of dealing with risk, farmers' cultural traditions, variability of soils within farms, water availability in different areas of a farm, and other farm-level variations. Even so, when preparing a project for an area where there is inadequate experience to rely on in forming subjectively determined cropping patterns or when dealing with very complex patterns, the project analyst may want to consult specialists in linear programming for assistance. In these cases, the project preparation takes on some of the character of a research effort. Because it is a well-known methodology widely used in farm management research, many agricultural colleges have staff familiar with linear programming.

In most agricultural projects, about half a dozen or so pattern farm investment analyses will suffice, but generalization about this is dangerous. The number of pattern farm analyses depends entirely on the complexity of the project. The analyst will want a pattern farm investment analysis for each major group of soil and water conditions in the project area and for each major difference in the size of holdings. Of course, each major cropping pattern or livestock activity will require a separate farm investment analysis. Remember that the objective is an indication of the effect of the project, not some kind of rigorously drawn, random sample. In practice, the number of farm budgets prepared for any given project analysis is a tradeoff between the complexity of the proposed project and the availability of staff to prepare the investment analyses.

Each farm investment analysis will be the result of careful consultation with technical specialists and interviews with farmers. Just as it is not possible to generalize about how many pattern farm budgets will be necessary, neither is it possible to generalize about how many interviews with farmers will be needed. Thorough preparation of a complex project may require twenty-five to fifty or even more interviews to provide the information for each farm analysis. But a simpler project that will use a better-known technology may require only half a dozen to a dozen interviews for each pattern farm budget. A group doing an appraisal of a proposed project would probably interview fewer farmers than was necessary in the initial project preparation. Each situation will have to be judged by itself in the light of how confident the analyst needs to be about the project analysis, how complex the project is, how well known the technology is, and how available are staff for project preparation.

Similar considerations apply in deciding the level of detail necessary in a farm investment analysis. Any farm investment analysis is intended to improve the decisionmaking for a project. It is, of necessity, an abstraction. This imprecision is forced on us by the very fact that we must predict future events, but it also arises from the question of just how much detail is necessary. In every farm investment analysis, the project analyst will reach a point at which further elaboration or further detail would make such a marginal contribution to the investment decision that it is not worth the time. Just when that point is reached will vary from project to project according to the circumstances of the project and the circumstances of the decisionmaking process.

It is easy to conceive of a set of pattern farm investment analyses that would be so enormously detailed and have so many different budgets that the process would quickly become bogged down in detail. Because of staff limitations and because of the approximate nature of the underlying data, it is better to hold both the number of pattern farms and the level of detail to the minimum that will serve to lay out clearly the major points about the project.

The project analyst will have to determine how best to present his information so that those who must review his work and make decisions about the project can work efficiently and yet have the information they need. The major entries, the level of detail, and the like will vary from project to project. Some of the elements given in separate tables in the illustrative examples in this chapter may be better combined in the tables that present a particular project. In many project reports, only a summary of background information, plus a detailed farm budget, will be needed. Other, more detailed tables can be included in annexes or in a separate volume of background information reproduced in limited quantities and circulated only to those most interested in the project. This kind of additional data can even be kept in a separate project information file that can be made available to anyone seriously interested. (In the Paraguay report used as an example in this chapter, the analyst presented his farm investment analysis in four annex tables and collected the supporting information in a separate project information file.)

What we will present here is a pattern format that includes the features most commonly of significance in agricultural project analysis. This pattern format uses a terminology generally accepted by both farm management specialists and accountants. In using the format, the analyst will have to determine for himself, for each project in his charge, exactly how much detail is necessary to support the analysis and exactly how this detail is best reported to facilitate decisions about the particular project.

Elements of Farm Investment Analysis

The principal elements of farm investment analysis are outlined in this subsection and are listed in table 4-2. A flow chart for preparing the analysis is given in figure 4-1. Not every element will be necessary in every analysis, and the means of presenting the elements will vary from project to project according to circumstances.

The most important elements of a farm investment analysis can be illustrated by an example adapted from the Paraguay Livestock and Agricultural Development Project. (Tables that illustrate particular elements of the analysis are noted in table 4-2.) The project is to increase agricultural production, productivity, and income on some 940 livestock farms and some 3,000 mixed farms, mostly small, through on-farm investments supported by credit, technical assistance, feeder roads, and market improvement. Most of the important aspects of preparing a farm investment analysis are touched on in this example, but it is clear that no single example can cover every possibility. Each project analyst will want to build on the illustrative tables that outline this one example for the purposes of his own project analysis. As in all accounts, the objectives of the farm investment account determine its content and format.

Accounting convention for farm investment analysis

Because farm investment analysis follows the principles of discounted cash flow, it is convenient to adopt an accounting convention that is congruent with those principles. [This convention has been called "time-adjusted" by Schaefer-Kehnert (1980), who has elaborated its use.] The discounting process used in discounted cash flow analysis implicitly assumes that every transaction falls at the end of the accounting period. It is desirable that the farm investment analysis match this assumption. This is simply accomplished if we consider the initial investment to take place at the end of year 1 of the project, regardless of whether it will actually take a full year or only a few weeks. Year 2, then, is the first accounting period in which increases in operating cost and incremental benefits occur. Thus, the dividing line between the end of the initial investment period and the beginning of the incremental production operations coincides exactly with the dividing line between years 1 and 2 of the project. (Some analysts accomplish much the same result by considering investment to fall in year 0, but this gives rise to problems when cash flows are aggregated.) Considering that preparing a farm plan, making a loan, constructing or purchasing investment items, and purchasing new inputs can take at least several months to a year, reserving year 1 for investment is not unrealistic. Doing so, however, is not dictated by real events but by the accounting convention.

If all transactions are considered to fall at the end of the accounting period, then we must allow for the availability of the needed operating

Table 4-2. Principal Elements of Farm Investment Analysis

Element	Illustrative table
Farm resource use	
Land use	4-4
(Land use calendar)	(Figure 4-2) Labor use
Annual labor requirement by crop operation, by crop for I hectare	4-5
Labor distribution by crop and month, per hectare	4-6
(Labor use diagram)	(Figure 4-3)
Labor requirement by crop and month	4-7
Hired labor by crop and month	4-8
Off-farm labor	Not illustrated
Farm production	
Crops and pasture	
Yield and carrying capacity	4-9
Crop and pasture production	4-10 Livestock
Herd projection	4-27
Herd composition, purchases, sales	4-11
Herd productivity	4-28
Feeding period and daily ration	4-29
Feed requirement and production	4-30
Yield per animal	Not illustrated Valuation
Farm-gate prices	4-12 Value of production
Crops	4-13
Livestock	
Incremental residual value	4-14
Farm inputs	
Investment	
Physical	4-15
Foreign exchange component	Not illustrated

Table 4-2. Principal Elements of Farm Investment Analysis

Element	Illustrative table
Value of investment	4-15 Operating expenditure
Crop	4-16 Livestock
Incremental working capital	4-17
Farm budget	
Without project	4-18 With project
Net benefit before financing	4-19
Debt service	4-24
Net benefit after financing	4-19
Cash position	4-19

Figure 4-1. Flow Chart for Farm Investment Analysis

expenditure at the beginning of the cropping season. This is accomplished by incorporating in the analysis an entry for incremental working capital at the end of the preceding year. The amount of the working capital needed is related to the farming system being analyzed. If a single annual crop is produced, then nearly all the operating expenditure will be needed at the beginning of the crop year. But if two crops are to be produced in succession, only the operating expenditure for the first crop need be on hand at the beginning of the crop year, since there will be a harvest during the year that will provide proceeds to replace the input supplies needed before the second crop is harvested. Thus, only half the total annual operating expenditure need be on hand at the beginning of the year. The incremental working capital needed (either an increase or a decrease) at the beginning of the year, then, is entered at the end of the year preceding the year when it will be expended for production. A set of recommended adjustments in incremental operating expenditure to obtain incremental working capital is given in table 4-3. Introducing an incremental working capital stream reflects real resource use. When an investment is undertaken, short-term inputs such as seed, fertilizer, feed, and the like must be on hand. They are replaced from the proceeds of the harvest or livestock sales during the year and are again on hand for production in the following year. If operations are to expand the next year, then stocks of inputs for production must be increased, and this will be reflected in another incremental working capital entry. Since the incremental working capital is entered separately, it will easily be included in the total investment shown when the farm budget is prepared and will not be inadvertently overlooked. At the end of the project, the incremental working capital for each year is added together algebraically and taken out of the project as part of the residual value. Thus, including incremental working capital in the accounts does not result in double counting.

One practical outcome of this accounting convention is that operating expenditures and benefits in year 1 generally remain the same as they were without the project. In some cases new investment might require an increase in operating expenditure in year 1, even though production

Table 4-3. Incremental Working Capital as a Percentage of Incremental Operating Expenditure

Item	Percent
Tree crops (slowly maturing,one harvest season)	100
Annual crops	
One season	80-100
Two seasons	40-60
Continuous cropping and continuously producing livestock enterprises	20-40

Source: Schaefer-Kehnert (1980).

would not be affected until year 2. In other instances, both operating expenditures and production might actually decrease-as might happen if new irrigation canals were to be constructed, disrupting farming operations. In laying out the farm investment analysis, however, it is usually considered that working capital is not freed as a result of the investment so that the layout of the farm budget can be simplified. If this were not done, both data for the case without the project and data for a "preproject" year or "year 1" would be needed to accommodate the decision rule that working capital be a proportion of the increase or decrease in the operating expenditure for the following year.

Showing working capital as a separate entry facilitates determining how much short-term credit may be needed by the farmer. A judgment may be made about whether the farmer will have savings from which to finance increased working capital or whether some proportion or all will have to be covered by extending the farmer a short-term loan, which then can be incorporated into the financing section of the farm budget.

The accounting convention adopted here is not much different from that most commonly used by project analysts. The most important difference is the rule of reserving year 1 for investment only and assuming the investment to fall at the end of the year. It is more common to include investment in year 1 but to assume that it will occur at the beginning of the year, even though the discounting process assumes it falls at the end of the year. Production is then assumed to be increased in year 1, an assumption that leads to an overestimate of the rate of return on the capital used. It also leads to a considerable overestimate of the farmer's income in the early years of the project and, hence, to an underestimate of his need for both long-term and short-term credit. The other difference between the accounting convention adopted here and that most commonly used by project analysts is only a matter of completeness. It is easy inadvertently to omit or underestimate working capital unless such capital is included in the convention. This convention for working capital leaves the crop year intact and therefore facilitates the supporting technical projections.

Farm resource use

Once the agronomists, livestock technicians, and other technical specialists have determined the components of a proposed farming system for a pattern farm, the analyst may proceed to prepare the farm investment analysis.

LAND USE.

The first step is to determine what the land use on the farm will be. The land use for the Paraguay project is given in table 4-4. Note that the crop year is taken to extend from July of one calendar year to June of the next, since this arrangement makes the break in the year come during the Paraguayan winter season, when there are the fewest crops in the ground. The total farm area is 20.0 hectares, divided into cultivated area, pasture, forest, and a house plot. (Throughout the text of this chapter,

Table 4-4. Land Use, 20-Hectare Mixed Farm, Livestock and Agricultural Development Project Model IV, Paraguay (hectares)

	Without project	With project					
Type of use and crops		Year 1	2	3	4	5	6-20
Cultivated area							
Maize	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Manioc	1.0	1.0	1.0	1.0	0.5	0.5	0.5
Beans	0.5	0.5	0.5	0.5	0.5	0.5	0.0
Cotton	2.0	2.0	2.0	2.0	2.2	2.5	3.0
Soybeans	0.0	0.0	1.0	1.0	2.2	2.5	3.0
Sunflower`	0.0	0.0	2.0	2.0	2.2	2.5	3.0
Total	4.0	4.0	7.0	7.0	8.1	9.0	10.0
Total croplands	4.0	4.0	5.0	5.0	5.9	6.5	7.0
Cropping intensity'	1.0	1.0	1.4	1.4	1.4	1.4	1.4
Pasture							
Natural	10.5	7.0	3.5	0.0	0.0	0.0	0.0
Improved	0.0	3.5	7.0	10.5	10.5	10.5	10.5
Total	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Forest	5.0	5.0	4.0	4.0	3.1	2.5	2.0
House plot	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total farm area	20.0	20.0	20.0	20.0	20.0	20.0	20.0

Source: Adapted from World Bank, "Staff Appraisal Report: Paraguay-Livestock and Agricultural Development Project," 2272-PP. (Washington, D.C., 1979; restricted circulation), annex 1, table 17.

a. Operated by one family with six members and a work potential of 70 work days a month. A work day is the time (generally eight hours) devoted by one person during one day.

b. Maize and manioc are intercropped.

c. Double-cropped after cotton or soybeans. The area given is the area planted in the year shown.

d. Does not include second crop area, in this case the area planted in sunflower.

e. Cropping intensity is determined by dividing the total cultivated area by the total cropland.

the most common or generalized categories from the pattern tables will be shown in italic type. These items would be considered in any farm investment analysis. In all tables the generalized analytical framework applies, but in some the categories are all specific to the project analyzed.)

The land use, in accord with the accounting convention adopted, would remain unchanged in year 1, except for establishment of improved pasture that is part of the investment. In year 2, in which the proposed cropping pattern calls for sunflower to be introduced and to be double-cropped after either cotton or soybeans (depending on the year), both the total cultivated area and the total cropland are shown. The total cultivated area is the total area planted in crops, whereas the total cropland is the area available to cultivate. When the total cultivated area is divided by the total cropland, the cropping intensity is obtained. In year 2, for example, the cropping intensity is 1.4 (7.0 - 5.0 = 1.4). Many analysts prefer to report cropping intensity in percentages, so this would be reported as 140 percent. One check of the feasibility of the cropping pattern is the intensity. The analyst should be cautious about accepting a cropping pattern that has a very high cropping intensity or one that is markedly different from the pattern existing in the area. Farmers may well have good reasons for not driving up the intensity.

Many analysts also like to devise a cropping diagram, such as that given in figure 4-2, and this should be subdivided to indicate any existing farm plots. Such a diagram is usually drawn up only for the full-development situation. The diagram indicates the area to be devoted to each category of land use and each crop. In the case of our example, it extends over two years to show that the seasonal timing of the cotton-sunflower-soybean rotation occurs on one plot in one year and on another in the next. Checking vertically at any one time, we can be sure the cropping pattern does not call for more area than the farm has. Checking horizontally, we can determine when each crop must be planted and whether enough land will be available at the proper season. The left and right sides of the boxes showing the area to be planted in each crop are slanted to indicate the planting and harvest time necessary for each crop. Examining the cropping diagram can help determine if there will be adequate time between crops to prepare the land.

Figure 4-2. Land Use Calendar for Project Years 6-20, 20-Hectare Mixed Farm, Livestock and Agricultural Development Project, Paraguay

LABOR USE

A second aspect of the farm resource use is labor. To determine the labor the farm will require, we need to know the labor used to cultivate a hectare of each crop in each project year. It is desirable to be able to see this in two forms, by operation and by month. Table 4-5 shows the annual labor requirements for 1 hectare by crop and operation for the Paraguay project example. It includes the labor required not only for the various crops to be produced, but also for the pasture. The labor unit is a work day, the time (generally eight hours) devoted by one person during one day. The labor requirement for crops drops sharply between years 1 and 2 because of the introduction of draft animal power. In the case of pasture, the labor requirement for fencing and seeding is included in years 1 through 3. In the Paraguay model, other activities of pasture establishment are to be undertaken by a contractor, so there will be no call for labor from the farmer. If, however, labor for establishing some other kind of improvement were expected, such as farmers' digging their own tertiary canals in an irrigation project, then this should be included in the labor requirement.

Table 4-5. Annual Labor Requirement per Hectare by Crop and Operation, 20-Hectare Mixed Farm, Paraguay Project

Crop and operation	Without-project	With Project						
		Year 1	2	3	4	5	6	7-20
Crops								
Maize								
Land preparation and planting	22	22	11	11	11	11	11	11
Cultivation'	9	9	2	2	2	2	2	2
Harvesting	28	28	28	31	31	33	33	36
Total	59	59	41	44	44	46	46	49
Manioc								
Land preparation and planting	14	14	10	10	10	10	10	10
Cultivation'	27	27	15	15	15	15	15	15
Harvesting	19	19	19	21	21	23	23	25
Total	60	60	44	46	46	48	48	50
Beans								
Land preparation and planting	24	24	19	19	19	19	19	19
Cultivation	10	10	4	4	4	4	4	4
Harvesting	20	20	20	22	22	22	22	22
Total	54	54	43	45	45	45	45	45
Cotton								
Clearing			8	8	8	8	8	8
Plowing	18	18	3	3	3	3	3	3
Harrowing (2 times)			2	2	2	2	2	2
Seeding	4	4	1	1	1	1	1	1
Thinning	6	6	6	6	6	6	6	6
Cultivation (3 times)	30	30	3	3	3	3	3	3
Spraying (5 times)	10	10	10	10	10	10	10	10
Harvesting	37	37	43	43	46	46	49	49
Drying, packing, marketing	4	4	4	4	4	4	4	4

Table 4-5. Annual Labor Requirement per Hectare by Crop and Operation, 20-Hectare Mixed Farm, Paraguay Project

Crop and operation	Without-project	With Project					
		Year 1	2	3	4	5	6	7-20
Total	109	109	80	80	83	83	86	86
Soybeans								
Clearing	-	-	8	8	8	8	8	8
Plowing	-	-	3	3	3	3	3	3
Harrowing (2 times)	-	-	2	2	2	2	2	2
Seeding	-	-	1	1	1	1	1	1
Thinning	-	-	6	6	6	6	6	6
Cultivation (2 times)	-	-	2	2	2	2	2	2
Spraying (2 times)	-	-	4	4	4	4	4	4
Harvesting	-	-	18	18	20	20	22	22
Transport	-	-	3	3	3	3	4	4
Total	-	-	47	47	49	49	52	52
Sunflower								
Clearing	-	-	6	6	6	6	6	6
Plowing	-	-	3	3	3	3	3	3
Harrowing (2 times)	-	-	2	2	2	2	2	2
Sowing	-	-	1	1	1	1	1	1
Thinning	-	-	6	6	6	6	6	6
Cultivation (2 times)	-	-	2	2	2	2	2	2
Spraying (2 times)	-	-	4	4	4	4	4	4
Harvesting	-	-	13	14	14	15	15	15
Drying, packing, marketing	-	-	4	4	4	5	5	5
Total	-	-	41	42	42	44	44	44
Pasture								
Improved establishment								
Fencing	-	7	7	7	0	0	0	0
Seeding	-	2	2	2	0	0	0	0

Table 4-5. Annual Labor Requirement per Hectare by Crop and Operation, 20-Hectare Mixed Farm, Paraguay Project

Crop and operation	Without-project	With Project						
		Year 1	2	3	4	5	6	7-20
Maintenance	-	-	3	3	3	3	3	3

Note: For the area in various crops, see table 4-4.

Source: Adapted from A. O. Ballantyne, "Paraguay-Small Farmer Credit Component, Livestock and Agricultural Development Project," working papers on file (Washington, D.C.: World Bank, 1978; restricted circulation).

a. Maize and manioc are intercropped. Hence, during the period when both are growing, the allocation of cultivation time between the two crops has an arbitrary element.

The total labor requirement per hectare for each crop is distributed by month in table 4-6. The monthly distribution is most important because we must determine not only the total annual labor requirement on the farm but also its timing to assess whether sufficient family labor will be available and, if there is not enough, how much hired labor will be needed. Although some farm management analysts break down the labor requirement by week or fortnight, for purposes of project analysis the monthly distribution is sufficient.

On a mixed farm, livestock will also require labor. This may be calculated by determining how much time will be needed per animal unit in the livestock herd. An animal unit is a measurement of feed demand by a particular class of animal. (This is discussed in more detail in the appendix to this chapter. The total animal units for each year are reported in table 4-11. They are given in that table for the livestock herd that could exist on 100 model farms to avoid the problem of divisibility that arises when the increase in large livestock on a small farm is projected. Thus, to obtain the animal units on one farm, the total reported in table 4-11 must be divided by 100. We will return to a discussion of this convention in the next subsection, when we discuss the herd composition.) In the Paraguay example, it is assumed that each animal unit will require five minutes of care a day and that the requirement will be the same each month throughout the year. The labor requirement is determined on the basis of the animal units at the beginning of the year. Using animal units rather

Table 4-6. Labor Distribution by Crop and Month, 20-Hectare Mixed Farm, Paraguay Project(work days per hectare)

Crop	J	A	S	O	N	D	J	F	M	A	M	J	Total
Maize													
Without project, year 1 14	14	8	0	5	4	28	0	0	0	0	0	0	59
Year 2 9	9	2	0	1	1	28	0	0	0	0	0	0	41
Years 3-4 9	9	2	0	1	1	31	0	0	0	0	0	0	44
Years 5-6 9	9	2	0	1	1	33	0	0	0	0	0	0	46

Table 4-6. Labor Distribution by Crop and Month, 20-Hectare Mixed Farm, Paraguay Project(work days per hectare)

Crop	J	A	S	O	N	D	J	F	M	A	M	J	Total
Years 7-20 9	9	2	0	1	1	36	0	0	0	0	0	0	49
Manioca													
Without project, year 1 0	0	0	14	3	3	3	4	3	5	3	3	19	60
Year 2 0	0	0	10	2	2	1	2	2	2	2	2	19	44
Years 3-4 0	0	0	10	2	2	1	2	2	2	2	2	21	46
Years 5-6 0	0	0	10	2	2	1	2	2	2	2	2	23	48
Years 7-20 0	0	0	10	2	2	1	2	2	2	2	2	25	50
Beans													
Without project, year 1 0	0	0	0	0	24	5	5	20	0	0	0	0	54
Year 2 0	0	0	0	0	19	2	2	20	0	0	0	0	43
Years 3-5 0	0	0	0	0	19	2	2	22	0	0	0	0	45
Cotton													
Without project, year 1 0	0	0	8	14	8	19	19	7	20	14	0	0	109
Years 2-3 0	0	0	8	6	8	6	5	8	25	14	0	0	80
Years 4-5 0	0	0	8	6	8	6	5	8	27	15	0	0	83
Years 6-20 0	0	0	8	6	8	6	5	9	28	16	0	0	86
Soybeans													
Years 2-3 0	0	0	0	0	13	8	3	2	10	8	3	0	47
Years 4-5 0	0	0	0	0	13	8	3	2	10	10	3	0	49
Years 6-20 0	0	0	0	0	13	8	3	2	11	11	4	0	52
Sunflower													
Year 2	2	9	3	13	4	0	0	0	0	0	6	4	41
Years 3-4	2	9	3	14	4	0	0	0	0	0	6	4	42
Years 5-20	2	9	3	15	5	0	0	0	0	0	6	4	44
Pasture													

Table 4-6. Labor Distribution by Crop and Month, 20-Hectare Mixed Farm, Paraguay Project(work days per hectare)

Crop	J	A	S	O	N	D	J	F	M	A	M	J	Total
Improved establish-ment													
Fencing	2	5	0	0	0	0	0	0	0	0	0	0	7
Seeding	0	0	0	0	2	0	0	0	0	0	0	0	2
Maintenance	0	0	0	0	0	0	0	1	0	0	1	1	3

Note: Same as table 4-5. Source: Same as table 4-5.

a. See note a, table 4-5.

b. Labor requirements for sunflower apply to the year of planting. Thus, in year 2 the labor requirement is for the crop planted in May of year 2 and harvested in October of year 3.

than each individual class of animal as the basis for estimating the labor requirement considerably simplifies the computation and is not unrealistic. In the convention recommended here, for example, closing livestock figures do not include heifers two to three years old or steers sold during the year, in this case steers three to four years old. Opening livestock figures, however, omit calves. In reality, closing and opening figures tend to balance each other, since heifers will be transferred to the breeding herd throughout the year and surplus heifers and steers will be sold throughout the year, whereas calves will be born throughout the year. Attempting a more precise estimate would only lead to superficial precision because the error in estimating the daily requirement for labor considerably exceeds any gain in accuracy.

Having determined the labor requirement for each crop or animal unit by month, we proceed to calculate the labor requirement for the pattern farm. This is given for the Paraguay example in table 4-7. Here the labor required for each crop during each project year is given. The total by month and the amount to be provided by family labor and by hired labor are determined. In the Paraguay example, it is assumed that the family on the pattern farm will have available 70 work days of labor a month and that any labor requirement in excess of this amount will be supplied by hired labor. This is a very mechanistic assumption, of course. Not only will families vary widely in the labor they have available-even on farms of quite comparable size and cropping pattern-but families will also tend to work longer hours in busy seasons and rest in the off-season. For purposes of the farm investment analysis, however, this approximation is quite sufficient, given the wide margin of error in the estimates of the labor requirement in general. In the Paraguay example, table 4-7 shows that hired labor will be needed on the farm from year 4 onward. By year 7, in the peak month of March, about 44 percent of the total labor required for cotton and soybeans will have to be hired.

When a labor budget shows a need for hired labor, as this example does, the project analyst must consider carefully whether the labor will be available in the project area. Totaling the hired labor requirement for the project as a whole is one of the real advantages of including the labor budget in the farm investment analysis, since the analyst must then consider the realism of the proposed pattern in light of the added hired labor that can reasonably be expected to be available in the project area. Postulating 56 additional work days of hired labor in March is one thing; whether such additional labor would be available for an entire proposed project is another. It may be that a proposed cropping pattern will prove unrealistic in its requirements of additional hired labor, and a less labor-intensive cropping pattern must be proposed. Furthermore, if the project will call for substantial amounts of additional hired labor in relation to the supply available in the region, this may have implications about the sources from which the labor must be drawn and, hence, about the opportunity cost of the hired labor. In turn, this opportunity cost will have to be considered when making the estimates of the economic value of the labor (see chapter 7).

Table 4-7. Labor Requirements by Crop and Month, 20-Hectare Mixed Farm, Paraguay Project

	Unit	J	A	S	O	N	D	J	F	M	A	M	J	Total
Without project														
Maize	0.5 ha	7	4	0	2	2	14	0	0	0	0	0	0	29
Manioc	1.0 ha	0	0	14	3	3	3	4	3	5	3	3	19	60
Beans	0.5 ha	0	0	0	0	12	2	2	10	0	0	0	0	26
Cotton	2.0 ha	0	0	16	28	16	38	38	14	40	28	0	0	218
Livestock	13.6 a.u.	4	4	4	4	4	4	4	4	4	4	4	4	48
Total		11	8	34	37	37	61	48	31	49	35	7	23	381
Family labor b		11	8	34	37	37	61	48	31	49	35	7	23	381
Hired labor		0	0	0	0	0	0	0	0	0	0	0	0	0
Year 1														
Maize	0.5 ha	7	4	0	2	2	14	0	0	0	0	0	0	29
Manioc	1.0 ha	0	0	14	3	3	3	4	3	5	3	3	19	60
Beans	0.5 ha	0	0	0	0	12	2	2	10	0	0	0	0	26
Cotton	2.0 ha	0	0	16	28	16	38	38	14	40	28	0	0	218
Livestock	13.6 a.u.	4	4	4	4	4	4	4	4	4	4	4	4	48
Improved pasture														
Fencing and seeding	3.5 ha	7	18	0	0	7	0	0	0	0	0	0	0	32
Total		18	26	34	37	44	61	48	31	49	35	7	23	413
Family labor		18	26	34	37	44	61	48	31	49	35	7	23	413
Hired labor		0	0	0	0	0	0	0	0	0	0	0	0	0
Year 2														
Maize	0.5 ha	4	1	0	0	0	14	0	0	0	0	0	0	19

Table 4-7. Labor Requirements by Crop and Month, 20-Hectare Mixed Farm, Paraguay Project

	Unit	J	A	S	O	N	D	J	F	M	A	M	J	Total
Manioc	1.0 ha	0	0	10	2	2	1	2	2	2	2	2	19	44
Beans	0.5 ha	0	0	0	0	10	1	1	10	0	0	0	0	22
Cotton	2.0 ha	0	0	16	12	16	12	10	16	50	28	0	0	160
Soybeans	1.0 ha	0	0	0	0	13	8	3	2	10	8	3	0	47
Sunflower`	2.0 ha	0	0	0	0	0	0	0	0	0	0	12	8	20
Livestock	17.2 a.u.	5	5	5	5	5	5	5	5	5	5	5	5	60
Improved pasture														
Fencing and seeding	3.5 ha	7	18	0	0	7	0	0	0	0	0	0	0	32
Maintenance	3.5 ha	0	0	0	0	0	0	0	4	0	0	4	4	12
Total		16	24	31	19	53	41	21	39	67	43	26	36	416
Family labor		16	24	31	19	53	41	21	39	67	43	26	36	416
Hired labor		0	0	0	0	0	0	0	0	0	0	0	0	0
Year 3														
Maize	0.5 ha	4	1	0	0	0	16	0	0	0	0	0	0	21
Manioc	1.0 ha	0	0	10	2	2	1	2	2	2	2	2	21	46
Beans	0.5 ha	0	0	0	0	10	1	1	11	0	0	0	0	23
Cotton	2.0 ha	0	0	16	12	16	12	10	16	50	28	0	0	160
Soybeans	1.0 ha	0	0	0	0	13	8	3	2	10	8	3	0	47
Sunflower	2.0 ha	4	18	6	26	8	0	0	0	0	0	12	8	82
Livestock	19.9 a.u.	6	6	6	6	6	6	6	6	6	6	6	6	72
Improved pasture														
Fencing and seeding	3.5 ha	7	18	0	0	7	0	0	0	0	0	0	0	32
Year 4														
Maize	0.5 ha	4	1	0	0	0	16	0	0	0	0	0	0	21
Manioc	0.5 ha	0	0	5	1	1	0	1	1	1	1	1	10	22
Beans	0.5 ha	0	0	0	0	10	1	1	11	0	0	0	0	23
Cotton	2.2 ha	0	0	18	13	18	13	11	18	59	33	0	0	183
Soybeans	2.2 ha	0	0	0	0	29	18	7	4	22	22	7	0	109

Table 4-7. Labor Requirements by Crop and Month, 20-Hectare Mixed Farm, Paraguay Project

	Unit	J	A	S	O	N	D	J	F	M	A	M	J	Total
Sunflower	2.2 ha	4	18	6	28	8	0	0	0	0	0	13	9	86
Livestock	22.7 a.u.	7	7	7	7	7	7	7	7	7	7	7	7	84
Improved pasture														
Maintenance	10.5 ha	0	0	0	0	0	0	0	10	0	0	10	10	30
Total		15	26	36	49	73	55	27	51	89	63	38	36	558
Family labor		15	26	36	49	70	55	27	51	70	63	38	36	536
Hired labor		0	0	0	0	3	0	0	0	19	0	0	0	22
Year 5														
Maize	0.5 ha	4	1	0	0	0	16	0	0	0	0	0	0	21
Manioc	0.5 ha	0	0	5	1	1	0	1	1	1	1	1	12	24
Beans	0.5 ha	0	0	0	0	10	1	1	11	0	0	0	0	23
Cotton	2.5 ha	0	0	20	15	20	15	12	20	68	38	0	0	208
Soybeans	2.5 ha	0	0	0	0	32	20	8	5	25	25	8	0	123
Sunflower	2.5 ha	4	20	7	31	9	0	0	0	0	0	15	10	96
Livestock	24.6 a.u.	8	8	8	8	8	8	8	8	8	8	8	8	96
Improved pasture														
Maintenance	10.5 ha	0	0	0	0	0	0	0	10	0	0	10	10	30
Total		16	29	40	55	80	60	30	55	102	72	42	40	621
Family labor		16	29	40	55	70	60	30	55	70	70	42	40	577
Hired labor		0	0	0	0	10	0	0	0	32	2	0	0	44
Year 6														
Maize	0.5 ha	4	1	0	0	0	16	0	0	0	0	0	0	21
Manioc	0.5 ha	0	0	5	1	1	0	1	1	1	1	1	12	24
Cotton	3.0 ha	0	0	24	18	24	18	15	27	84	48	0	0	258
Soybeans	3.0 ha	0	0	0	0	39	24	9	6	33	33	12	0	156
Sunflower	3.0 ha	5	22	8	38	12	0	0	0	0	0	18	12	115
Livestock	25.1 a.u.	8	8	8	8	8	8	8	8	8	8	8	8	96
Improved pasture														

Table 4-7. Labor Requirements by Crop and Month, 20-Hectare Mixed Farm, Paraguay Project

	Unit	J	A	S	O	N	D	J	F	M	A	M	J	Total
Maintenance	10.5 ha	0	0	0	0	0	0	0	10	0	0	10	10	30
Total		17	31	45	65	84	66	33	52	126	90	49	42	700
Family labor		17	31	45	65	70	66	33	52	70	70	49	42	610
Hired labor		0	0	0	0	14	0	0	0	56	20	0	0	90
Years 7-20														
Maize	0.5 ha	4	1	0	0	0	18	0	0	0	0	0	0	23
Manioc	0.5 ha	0	0	5	1	1	0	1	1	1	1	1	12	24
Cotton	3.0 ha	0	0	24	18	24	18	15	27	84	48	0	0	258
Soybeans	3.0 ha	0	0	0	0	39	24	9	6	33	33	12	0	156
Sunflower	3.0 ha	6	27	9	45	15	0	0	0	0	0	18	12	132
Livestock	25.0 a.u.	8	8	8	8	8	8	8	8	8	8	8	8	96
Improved pasture														
Maintenance	10.5 ha	0	0	0	0	0	0	0	10	0	0	10	10	30
Total		18	36	46	72	87	68	33	52	126	90	49	42	719
Family labor		18	36	46	70	70	68	33	52	70	70	49	42	624
Hired labor		0	0	0	2	17	0	0	0	56	20	0	0	95

ha = Hectares; a.u.= animal units.

Source: Calculated from tables 4-4 and 4-6.

a. Assumes five minutes a day per animal unit, eight hours a day, and thirty days a month. The labor requirement is based on the animal units at the beginning of the year (as given in table 4-11) divided by 100 to give the labor requirement for a single farm. See text (the subsection "Farm production. Livestock") for a discussion of this convention.

b. Assumes 70 work days per month of available family labor.

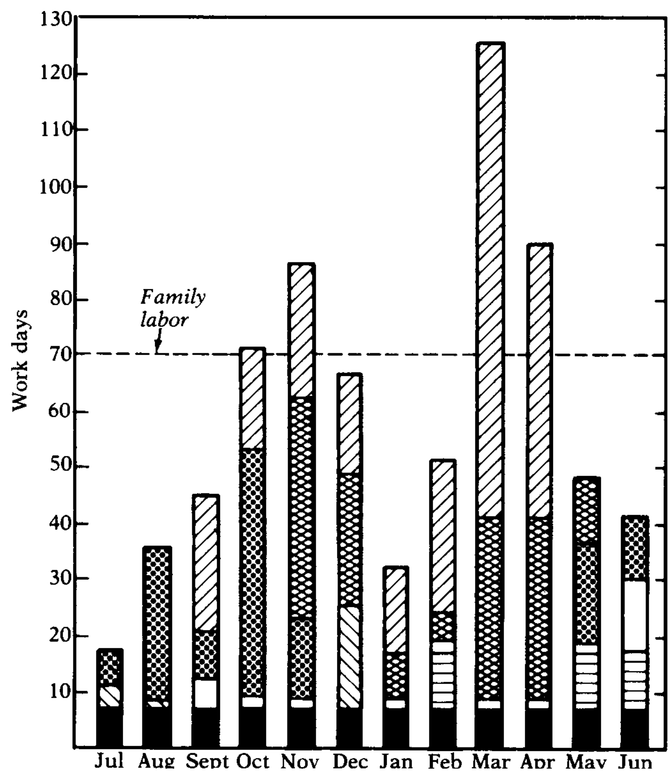
c. Area and labor requirement for sunflower apply to the year of planting. Thus, the area assumed in the first five months of project year 5 is the 2.2 hectares planted in May of project year 4.

d. Calculated on the basis of improved pasture established in previous years (as shown in table 4-4). Thus, in year 2 it is based on 3.5 hectares and in year 3 on 7.0 hectares.

Some analysts like to work out a labor use diagram such as the one shown in figure 4-3. This usually is done only for the full-development situation. The graphic presentation makes the problem of peak labor requirements readily apparent.

Once the total hired labor has been determined, it must be allocated among the various crops so that it may be included in the proper category of operating expenditure. This is done in table 4-8. In the Paraguay example the allocation is made in proportion to the total work days

Figure 4-3. Labor Use Diagram for Project Years 7-20, 20-Hectare Mixed Farm, Paraguay Project



Source: Table 4-7.

required for each cash crop in each month for which hired labor would be needed. In other circumstances, such a mechanistic allocation would be inappropriate. In many areas, certain crop operations are done by hired labor and not by family labor, even if family labor is available. Thus, in Southeast Asia, transplanting rice is done in many areas entirely by hired labor; the only family labor engaged is that of the farmer himself, who supervises the work. Both the amount of hired labor and its allocation among crops should be closely related to the expected cultural practices of people in the project area.

Farm production

Having determined the use of land and labor resources for the pattern farm, the analyst next assesses the projected farm production. The investment analysis of crop and pasture and livestock production is discussed in this subsection, and issues of valuation (both of farm production and incremental residual value on the farm) are addressed.

Table 4-8. Hired Labor by Crop and Month, 20-Hectare Mixed Farm, Paraguay Project (work days)

Year and crop	J	A	S	O	N	D	J	F	M	A	M	J	Total
Year 4													
Cotton	0	0	0	0	1	0	0	0	14	0	0	0	15
Soybeans	0	0	0	0	2	0	0	0	5	0	0	0	7
Total	0	0	0	0	3	0	0	0	19	0	0	0	22
Year 5													
Cotton	0	0	0	0	3	0	0	0	23	1	0	0	27
Soybeans	0	0	0	0	5	0	0	0	9	1	0	0	15
Sunflower	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	0	0	0	0	9[b]	0	0	0	32	2	0	0	43[6]
Year 6													
Cotton	0	0	0	0	4	0	0	0	40	12	0	0	56
Soybeans	0	0	0	0	7	0	0	0	16	8	0	0	31
Sunflower	0	0	0	0	2	0	0	0	0	0	0	0	2
Total	0	0	0	0	13[b]	0	0	0	56	20	0	0	89[6]
Years 7-20													
Cotton	0	0	0	1	5	0	0	0	40	12	0	0	58
Soybeans	0	0	0	0	8	0	0	0	16	8	0	0	32
Sunflower	0	0	0	1	3	0	0	0	0	0	0	0	4
Total	0	0	0	2	16[b]	0	0	0	56	20	0	0	94

Source: Calculated from table 4-7.

a. Hired labor is allocated to cash crops-cotton, soybeans, and sunflower-in proportion to their total labor requirements in that month. In November of year 4, for example, 55 work days are required for cash crops, of which 3 work days are to be hired. Eighteen work days are required for cotton. To determine the hired labor for cotton, the proportion of total labor required for cash crops that is to be applied to cotton is multiplied by the total hired labor requirement for the month; this gives the hired labor to be applied to cotton, or 1 work day {[18 _ (18 + 29 + 8)] x 3 = i}.

b. Does not equal the total in table 4-7 because of rounding.

CROPS AND PASTURE.

For crops and pasture, the yield and carrying capacity are tabulated as illustrated in table 4-9. In the table, yields are shown only for crops and pasture actually in the cropping pattern in the year reported. Thus, no without-project yield is reported for soybeans, whereas for sunflower, which will be planted following cotton in year 2, yield is reported only beginning in year 3 since the first crop is not harvested until that time.

Multiplying the production per hectare by the number of hectares of each of the crops and of pasture in the land use pattern shown in table 4-4, we obtain the crop and pasture production illustrated in table 4-10. Again, since sunflower is first planted in year 2 but first harvested in year 3, the production from the first planting of 1.8 tons is shown in year 3. Similarly, sunflower planted each year produces in the following year.

Because all the feed for the livestock to be produced on the pattern farm in the Paraguay project is assumed to come from pasture, no deduction is made in table 4-10 for crops to be used for feed. Should the production pattern of a model farm call for the use of crops and crop by-products for feed, table 4-10 would then be adjusted to show that use. Total production of crops would be shown and expanded to include crop by-products if these were to be fed or if they have a sale value. From this total would be deducted the feed consumption taken from an estimate of feed requirement and production such as that illustrated in table 4-30. The result would be the net production available for sale or household consumption.

LIVESTOCK.

Herd composition, purchases, and sales are given in table 4-11. Projecting the herd (or flock) composition, purchases, and sales in a farm investment analysis that involves livestock introduces a computational process that can become quite complex.

Table 4-9. Yield and Carrying Capacity, 20-Hectare Mixed Farm, Paraguay Project

Product	Without-project	With project						
		1	2	3	4	5	6	7-20
Crops (tons/ha)								
Maize	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.4
Manioc	18.0	18.0	18.0	20.0	20.0	22.0	22.0	24.0
Beans	0.9	0.9	0.9	1.0	1.0	1.0	-	-
Cotton	1.3	1.3	1.5	1.5	1.6	1.6	1.7	1.7
Soybeans	-	-	1.4	1.4	1.6	1.6	1.8	1.8
Sunflower	-	-	-	0.9	1.0	1.1	1.2	1.2
Pasture (a.u./ha)								
Natural	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Improved	-	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Source: Same as table 4-4.

Table 4-10. Crop and Pasture Production, 20-Hectare Mixed Farm, Paraguay Project

Product	Without project	With project						
		1	2	3	4	5	6	7-20
Crops								
Total production								
Maize	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7
Manioc	18.0	18.0	18.0	20.0	10.0	11.0	11.0	12.0
Beans	0.4	0.4	0.4	0.5	0.5	0.5	-	-
Cotton	2.6	2.6	3.0	3.0	3.5	4.0	5.1	5.1
Soybeans	-	-	1.4	1.4	3.5	4.0	5.4	5.4
Sunflower a	-	-	-	1.8	2.0	2.4	3.0	3.6
Feed consumption								
Maize	-	-	-	-	-	-	-	-
Manioc	-	-	-	-	-	-	-	-
Soybeans	-	-	-	-	-	-	-	-
Sunflower	-	-	-	-	-	-	-	-
Net production								
available for								
sale or house-								
hold consumption								
Maize	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7
Manioc	18.0	18.0	18.0	20.0	10.0	11.0	11.0	12.0
Beans	0.4	0.4	0.4	0.5	0.5	0.5	-	-
Cotton	2.6	2.6	3.0	3.0	3.5	4.0	5.1	5.1
Soybeans	-	-	1.4	1.4	3.5	4.0	5.4	5.4
Sunflower	-	-	-	1.8	2.0	2.4	3.0	3.6
Pasture								
Carrying capacity								
(animal units)	12.6	17.2	21.7	26.2	26.2	26.2	26.2	26.2

Source: Calculated from tables 4-4 and 4-9.

a. Sunflower is harvested in the year following planting. Thus, the production in year 2 is zero, and in year 3 it is 1.8 tons, which is determined by multiplying the 2.0 hectares planted in year 2 by the yield of 0.9 tons per hectare harvested in year 3 (2.0 x 0.9 = 1.8).

b. If there were a substantial livestock production activity on the farm that used crops for feed, the amounts would be estimated in a feed requirement and production table such as table 4-30 and tabulated here. The table would be expanded to include crop by-products used for feed. As indicated, the use of crops for feed would be deducted from the total production, and the result would be the net production available for sale or household consumption.

Herd projections are done to forecast use of future facilities, pasture, or feed by applying technical coefficients, such as those shown at the bottom of table 4-11, to trace the changes in the size and composition of the herd.

For poultry, stall feeding, or feedlot projections, it is usually assumed that enough young animals can be purchased in a given year to bring the numbers up to the level of feed availability or of proposed production facilities. Brown (1979, pp. 76-85) gives a methodology for broiler and egg production. For pigs, a projection is made applying the technical coefficients; since the gestation period of swine is short, the projection is simplified and uncomplicated.

Table 4-11. Herd Composition, Purchases, and Sales, 100 20-Hectare Mixed Farms, Paraguay Project (head)

		With Project						
Item	**Without Project**	**1**	**2**	**3**	**4**	**5**	**6**	**7-20**
Herd composition at beginning of year								
Bulls	100	100	100	100	100	100	100	100
Breeding cows	500	500	655	800	800	800	800	800
Heifers 1-2 years	157	157	157	221	294	285	285	285
Heifers 2-3 years	152	152	152	152	217	288	279	279
Steers 1-2 years	157	157	157	221	294	285	285	285
Steers 2-3 years	152	152	152	152	217	288	279	279
Steers 3-4 years	147	147	147	147	149	213	282	273
Work oxen		0	200	200	200	200	200	200
Total	1365	1365	1,720	1,993	2,271	2,459	2,510	2,501

Animal units	1365	1365	1,720	1,993	2,271	2,459	2,510	2,501
Carrying capacity								
(beginning of year)'	1260	1260	1,720	2,170	2,620	2,620	2,620	2,620
Purchases								
Bulls	18	33	20	20	20	20	20	20
Heifers 2-3 years	0	91	131	2	0	0	0	0
Steers 1-2 years	0	0	0	0	0	0	0	0
Work oxen	0	200	38	36	36	36	36	36
Total	18	324	189	58	56	56	56	56
Sales (including culls)								
Culled bulls	15	30	17	18	18	18	18	18
Culled cows	60	60	98	120	112	112	112	112
Culled heifers	8	8	15	15	22	29	28	28
Surplus heifers 2-3 years	64	0	0	0	63	125	117	117
Steers 1-2 years	0	0	0	0	0	0	0	0
Steers 3-4 years	143	143	143	144	146	209	276	268
Culled work oxen		0	32	32	32	32	32	32
Total	290	241	305	329	393	525	583	575
Herd productivity								
(percent)'			20					23
Technical coefficients (percent)								
Calving rate	70	70	75	80	75	75	75	75
Calf mortality	10	10	10	8	5	5	5	5
Adult mortality	3	3	3	2	2	2	2	2
Culling rate (bulls)	15	30	17	18	18	18	18	18
Culling rate (cows)	12	12	15	15	14	14	14	14
Culling rate (heifers)	5	5	10	10	10	10	10	10

Culling rate (work oxen)		0	16	16	16	16	16	16
Bulls/breeding femalesd								
Carrying capacity								
(per hectare; end of year)'	1.2	1.6	2.1	2.5	2.5	2.5	2.5	2.5

Source: Same as table 4-4 (annex 1, table 18). See computations in table 4-27.

a. In animal units. The carrying capacity at the beginning of the year is determined by multiplying the animal units per farm at the end of the previous year (given in table 4-10) by the 100 farms in the model. The carrying capacity per hectare at the end of the year is determined by dividing the animal units per farm by the 10.5 hectares of pasture on each farm; it is thus a weighted average of natural and improved pasture.

b. Herd productivity is the sum of the off-take rate and the herd growth rate. Only the values for a stable herd are given.

c. Represents a weighted average between the calving rate of breeding cows in the existing herd, which is 70 percent, and that of purchased in-calf heifers, which is nearly 100 percent.

d. Note that in this project a minimum of one bull per farm is assumed, or a minimum of 100 bulls on 100 farms. Normally the number of bulls per 100 breeding females would be three or four for all years.

The projection can become computationally quite complicated, however, for larger animals fed mainly pasture, such as sheep or cattle used for dairy or beef production. The project analyst often relies on the livestock technician for these projections and simply incorporates them into his farm investment analysis. But livestock technicians themselves may be unfamiliar with the details of how to make these computations-and especially with how to make them so they conform to the accounting convention adopted here for the farm investment analysis. For this reason, the computation for the herd projection in the Paraguay example is discussed in considerable detail in the appendix to this chapter (where definitions of the specialized livestock terms may also be found). This methodology can be adapted, with only minor variations, to projections for dairy animals. As in the treatment here, the details of the projection need not form part of the main body of most project reports; only a summary need be given (as in table 4-11 from the Paraguay example), with the details laid out in an annex or in the project file.

Projecting the herd composition on a small farm when larger animals are to be produced introduces the difficult problems of divisibility. As noted, herd projections for animals that are mainly grazed on pasture are based on the estimated feed availability. Technical coefficients, such as mortality and calving rates, are often directly influenced by the amount of available feed, but in cattle production changes do not happen immediately. For example, an increase in feed availability in one season will improve the calving rate and decrease calf losses only during the next season.

The projected coefficients are applied to the herd at the beginning of the project. The result begins to appear in the herd composition at the beginning of year 2. Often, the projected coefficients indicate that the herd's composition and its overall size will not change fast enough to utilize the increased feed available. As a solution, in-calf heifers can be purchased to increase the reproductive component of the herd, or feeder steers can be purchased for fattening until the herd can utilize the forage resources.

This use of technical coefficients raises few problems of interpretation for larger farms or ranches with herds of 100 or more animals. For small farms, however, the technical coefficients lead to many "fractional animals." In the Paraguay example, for instance, at full development from years 7 through 20 the farm is expected to have eight breeding cows. The adult mortality is expected to be 2 percent, so do we report that 0.16 cows die each year (8 x 0.02 = 0.16)? Such nonsensical results have led project analysts to seek means to overcome the divisibility problem. Some have simply ignored technical coefficients, such as mortality, that result in very small, fractional animal figures. This omission, however, considerably distorts the pattern farm investment analysis. To avoid such distortion, other analysts have devised systems that carry fractional animals in the computation until the fractions add up to a whole animal, which is then reported. In the Paraguay example, for instance, the calving rate at full development is 75 percent. Thus, six calves are born, of which half may be expected to be female. Calf mortality is 5 percent, and this gives a figure of 2.8 to be carried over to the next year as heifers 1-2 years old [8 x 0.75 - 2 - (8 x 0.75 - 2 x 0.05) = 2.8]. Of these, 2 percent are reported and 0.8 is carried over to the following year, which then will show a figure of 3.6 (0.8 + 2.8 = 3.6). Of these, 3 are reported and 0.6 is carried forward, and so forth.

Mortality may sometimes be treated by incorporating a more formal probability assumption. Such systems become quite complex and in the end do not satisfactorily project an individual small herd. Another approach that is increasingly used-and that is adopted and recommended here-is to do the herd projection for a number of farms, say 100, that will contain or eliminate the divisibility problem. Purchases and sales are then valued, and only the values are entered in the farm investment analysis for a single pattern farm. In effect, this says that on the average a farm will have a certain level of purchases and sales. This, too, is not a fully satisfactory convention. Its results do not state, for example, how many animals are actually on the farm at any given time. It does have the virtue, however, of being simpler than other systems-even if it is still quite complex-and of generating somewhat less distortion.

Project designers may want to introduce an insurance scheme to protect project participants from, say, the loss of a bull. Then, in effect, the values in the farm investment analysis for a single farm for the purchase of bulls include an insurance premium that insures that the farmer will be reimbursed in the event of the death of a bull. Such insurance schemes are found in developing countries, but they give rise to possibilities of abuse and to difficult administrative problems, and they often are not very effective.

In the Paraguay example summarized in table 4-11, the herd composition is given for each major class of animals without the project and for each project year. (The table is drawn from the worksheet reproduced in table 4-27.) Note that the analyst assumed that each farm would have a bull, so that the number of bulls remains 100, many more than would be needed if the analysis were, indeed, for a single herd rather than for 100 small farms. Note, also, the purchase of draft animals at the end of the first year. It is assumed that each farm will purchase two work oxen. The total animal units for the herd are shown, and for convenience this figure is compared with the carrying capacity. As noted in the appendix to this chapter, the number of breeding cows has been rounded to an even multiple of the number of farms in the model so that each farm has five breeding cows without the project and increases its herd to eight breeding cows at full development. As a result, the total of animal units does not very closely approximate the carrying capacity. Since estimates of carrying capacity are quite approximate, however, overstocking of up to 10 percent would probably be acceptable.

Purchases of each class of animal are treated next in the investment analysis; these will form the basis for the investment and operating expenditure for the livestock aspect of the 20-hectare mixed farm. The sales give the basis for the inflow for the farm. The herd productivity, a measure of the efficiency of the herd, is also given; it relates the number of head sold plus the increase in herd size to the number of head carried at the beginning of the year. Only the figures for the stable herd without the project and at full development are given. The dynamics of herd growth tend to distort the measure during the period when the herd is increasing in size. (The details of the computation are given in table 4-28.) Finally, the technical coefficients for the herd are given. These are crucial parameters of the herd growth and are indicators of management effectiveness, animal health care, and feed availability.

When feed concentrates are important in the farm production pattern, it may be desirable to project the feed requirements the livestock activity will involve. (An illustrative example is included in tables 4-29 and 4-30 in the appendix to this chapter in connection with the discussion of herd projections.)

In some instances it may be desirable to report yield per animal if the valuation system is based, say, on kilograms. In the Paraguay example the prices are based on individual animals without regard to weight, so yield per animal is not needed and is therefore not illustrated.

VALUATION

To begin the valuation of the farm production, the farm-gate prices for items entering the farm investment analysis are listed as shown in table 4-12. (The symbol for Paraguayan guaranis is 0.) If a farm-gate price is used in only one table of the investment analysis, it may not be included in the farm-gate price table but may appear in the appropriate table. (Such is the case, for example, of the prices for land improvement, which are included in table 4-15, devoted to investment, and not in the table of farm-gate prices.) Some farm-gate prices were collected and projected by the project analyst on the basis of field observation. Other prices were collected in the field but forecast using the projections of the World Bank. Prices and their derivation were discussed in more detail in chapter 3.

The value of production for the farm is given in table 4-13. For crops, values are determined by multiplying the production in table 4-10 by the price per ton in table 4-12. For livestock, the value is obtained by multiplying sales from table 4-11 by the price per animal given in table 4-12. The product is then divided by 100 to give the value for a single farm, in line with the convention recommended to avoid the divisibility problem.

INCREMENTAL RESIDUAL VALUE

In the last year of the farm investment analysis, the incremental residual (or terminal) value on the farm is

Table 4-12. Farm-Gate Prices, 20-Hectare Mixed Farm, Paraguay Project

	Project year			
I tem	**1**	**2**	**3-5**	**6-20**
Farm labor (per work day)	0.3	0.3	0.3	0.3
Crops (per ton)				
Maize	12.0	12.0	12.0	12.0
Manioc	3.0	3.0	3.0	3.0
Beans	28.0	28.0	28.0	28.0
Cotton	44.4	45.1	45.1	44.9

Table 4-12. Farm-Gate Prices, 20-Hectare Mixed Farm, Paraguay Project

	Project year			
I tem	1	2	3-5	6-20
Soybeans	23.6	20.9	26.2	28.9
Sunflower	20.0	20.0	20.0	20.0
Livestock (per head)				
Bulls	30.0	30.0	32.4	33.6
Culled bulls	23.0	23.0	24.8	25.8
Breeding cows	18.7	18.7	20.2	20.9
Culled cows	17.0	17.0	18.4	19.0
Heifers 1-2 years	12.5	12.5	13.5	14.0
Heifers 2-3 years	18.7	18.7	20.2	20.9
Culled heifers 2-3 years	17.0	17.0	18.4	19.0
Steers 1-2 years	12.5	12.5	13.5	14.0
Steers 2-3 years	18.7	18.7	20.2	20.9
Steers 3-4 years	23.0	23.0	24.8	25.8
Work oxen	35.0	35.0	37.8	39.2

Source: Same as table 4-4.

a. Prices of maize, soybeans, and livestock are adjusted for the real price changes projected by the Commodities and Export Projections division of the World Bank. Other prices are assumed to remain constant in real terms.

included among the inflows in the farm budget and "credited" to the project investment. This is done because not all the utility of an investment may be exhausted in the course of a project. Note that it is the incremental value that is sought, not the total value. In some instances there is no distinction, since the value of an item such as construction may be entirely incremental. But for items such as land, livestock, and working capital, there may have been values existing at the beginning of the project, and only the incremental residual value may properly be credited to the project investment. Since the incremental residual value enters the farm investment analysis in the final year, it bears relatively little weight in the discounting process. As a result, rather broad estimates of residual values are acceptable in project analysis.

Three kinds of residual value may be noted. The first is the salvage value of capital assets that have been largely consumed by the end of the project and that, for the most part, can only be salvaged for their scrap value or have only a short portion of their normal life expectancy remaining at the end of the project period. Buildings and other construction or machinery such as irrigation pumps or tractors are common examples. A second kind of residual value is the working capital. This is automatically allowed for under the accounting convention we have adopted for the farm investment analysis. The third kind of residual value is the value of items that have a substantial useful life remaining at the end of the project and may even have increased in value as a result of the project investment; land with associated improvements and a livestock herd are examples.

All three kinds of residual value are illustrated for the Paraguay example in table 4-14. In a land improvement project such as this one, there usually would be an entry for the incremental value of land, although in this instance the analyst chose not to include it because the site in Paraguay is a frontier area and the land market is not very active. In more crowded societies where a project involves land improvement such as better irrigation and drainage, the incremental value of the land might be quite substantial. Next for consideration would be the incremental residual value of construction. In the Paraguay example, the construction is all incremental, so the incremental residual value is quite simply obtained by taking a proportion of the initial construction, in this case 10 percent. The incremental residual value of equipment is assumed to be negligible, although that would not necessarily be the case in other projects. Then the analyst considers the incremental value of livestock. In this case, care must be taken to distinguish between the total residual value of the livestock herd and the incremental residual value. There was, of course, a livestock herd at the beginning of the project, so only the increased value of the herd at the end of the project can be attributed to the project investment itself. Hence, each class of animals is valued at the beginning of the project and at the end of the project, and only the difference-or incremen-tis carried forward as the incremental residual value. Finally, there is the total incremental working capital. The reader will recall that, in the discussion of the accounting convention for farm investment analysis, considerable attention was devoted to estimating the incremental working capital year by year. Once this is done, all that is needed to obtain the total incremental working capital is simply to add the incremental working capital for each year algebraically-that is, adding the increases and subtracting decreases-to obtain the incremental residual value entered in the final year.

Farm inputs

When the estimates of production are complete, the estimates of the necessary inputs may be prepared. Inputs comprise the investment, operating expenditure, and incremental working capital for the project.

INVESTMENT

Investment for the project is a crucial element. The investment contemplated for the Paraguay pattern farm is given in table 4-15. It is convenient to show the unit and unit cost in the investment table; for convenience, items appearing only in the investment table may be omitted from the farm-gate price table. As in this presentation, the total physical investment may be incorporated in the investment cost

Table 4-13. Value of Production, 20-Hectare Mixed Farm, Paraguay Project

	Without project				With project						
Item	**Year 1**	**2**	**3-5**	**6-20**	**1**	**2**	**3**	**4**	**5**	**6**	**7-20**
Crops											
Maize	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	8.4
Manioc	54.0	54.0	54.0	54.0	54.0	54.0	60.0	30.0	33.0	33.0	36.0
Beans	11.2	11.2	11.2	11.2	11.2	11.2	14.0	14.0	14.0	-	-

Cotton	115.4	117.3	117.3	116.7	115.4	135.3	135.3	157.8	180.4	229.0	229.0
Soybeans	-	-	-	-	-	29.3	36.7	91.7	104.8	156.1	156.1
Sunflower	-	-	-	-	-	-	36.0	40.0	48.0	60.0	72.0
Total	187.8	189.7	189.7	189.1	187.8	237.0	289.2	340.7	387.4	485.3	501.5
Livestock [b]											
Culled bulls	3.4	3.4	3.7	3.9	6.9	3.9	4.5	4.5	4.5	4.6	4.6
Culled cows	10.2	10.2	11.0	11.4	10.2	16.7	22.1	20.6	20.6	21.3	21.3
Culled heifers	1.4	1.4	1.5	1.5	1.4	2.6	2.8	4.0	5.3	5.3	5.3
Surplus heifers	12.0	12.0	12.9	13.4	0	0	0	12.7	25.2	24.5	24.5
Steers 3-4 years	32.9	32.9	35.5	36.9	32.9	32.9	35.7	36.2	51.8	71.2	69.1
Culled work oxen	-	-	-	-	-	7.4	7.9	7.9	7.9	8.3	8.3
Total	59.9	59.9	64.6	67.1	51.4	63.5	73.0	85.9	115.3	135.2	133.1
Total value	247.7	249.6	254.3	256.2	239.2	300.5	362.2	426.6	502.7	620.5	634.6

Source: Calculated from tables 4-10, 4-11, and 4-12.

a. Production from table 4-10 multiplied by the price per ton from table 4-12. For year 2 without the project, for example, the value of cotton is the without-project production from table 4-10 times the price in year 2 in table 4-12.

b. Sales from table 4-11 multiplied by the price per animal from table 4-12; product is then divided by 100 to give the value for a single farm. See text for a discussion of this convention.

Table 4-14. Incremental Residual Value, 20-Hectare Mixed Farm, Paraguay Project

Item	At beginningof project	Value at end of project	Incremental
Land	a	a	a
Construction [b]	0	18.0	18.0
Equipment`	0	0	0
Livestock [d]			
Bulls	30.0	33.6	
Breeding cows	93.5	167.2	
Heifers 1-2 years	19.6	39.9	

Heifers 2-3 years	28.4	58.3	
Steers 1-2 years	19.6	39.9	
Steers 2-3 years	28.4	58.3	
Steers 3-4 years	33.8	70.4	
Work oxen	-	78.4	
Total	253.3	546.0	292.7
Working capital'	-	-	119.9
Total			430.6

Source: Calculated from other tables as noted.

a. In the Paraguay example, the analyst chose not to include an incremental value of land improvements in his computation of residual value. This amount usually is included if there has been substantial land improvement.

b. The residual value of construction is taken as 10 percent of the total construction investment given in table 4-15.

c. The residual value of equipment is assumed to be negligible. Only equipment purchased for the project is included in the computation, not the equipment existing on the farm at the beginning of the project.

d. The value of the livestock at the beginning of the project is calculated from the herd composition at the beginning of the year in table 4-11 multiplied by the year-1 prices in table 4-12. The value of the livestock at the end of the project is calculated from the year-20 herd composition in table 4-11 multiplied by the year-20 prices in table 4-12.

e. From table 4-17.

table; in other instances, a separate table may be needed. Although it is not shown for the Paraguay example, including the foreign exchange component of the investment cost is often desirable. It is important that an agricultural project report detail the foreign exchange needed for the project because the availability of foreign exchange may be a major constraint.

Investment for the Paraguay example is divided into land improvement, construction, equipment, and livestock, the major categories likely to be found in an agricultural project. Within each category the major items are noted, and the investment for them is tabulated by project year. The total investment by year and for the pattern as a whole is given. Note how the analyst accommodated the existing equipment found on project farms in this pattern by listing equipment totaling 0206 thousand, but then subtracting 050 thousand as an average of existing equipment.

For livestock, it is assumed that all heifer purchases and culling in excess of that normally done without the project are an investment.

Table 4-15. Investment, 20-Hectare Mixed Farm, Paraguay Project

	Unit Cost	Project year			Total
Item		1	2	3	

Land improvement (per hectare)					
Clear, cut and burn					
forestb	15.0	52.5	52.5	52.5	157.5
Destumping`	20.0	100.0	0	40.0	140.0
Pasture					
establishment [d]	1.0	3.5	3.5	3.5	10.5
Total		156.0	56.0	96.0	308.0
Construction (per single unit)					
Storage	40.0	40.0	0	0	40.0
Welle	50.0	50.0	0	0	50.0
Fencing wire (for 1 ha)	8.6	30.1	30.1	30.1	90.3
Total		120.1	30.1	30.1	180.3
Equipment (per single unit)					
Plow	18.0	18.0	0	0	18.0
Disc harrow	65.0	65.0	0	0	65.0
Seeder	30.0	30.0	0	0	30.0
Cultivator	17.0	17.0	0	0	17.0
Ox cart	50.0	50.0	0	0	50.0
Sprayer	11.0	11.0	0	0	11.0
Hand tools	15.0	15.0	0	0	15.0
Subtotal		206.0	0	0	206.0
Less existing					
equipmentf		(50.0)	0	0	(50.0)
Total		156.0	0	0	156.0
Livestock (per head)[9]					
Heifers 2-3 years [h]	-	17.0	24.5	0.4	41.9
Bulls'	30.0	4.5	0	0	4.5
Work oxen'	35.0	70.0	0	0	70.0
Total		91.5	24.5	0.4	116.4
Total investment		523.6	110.6	126.5	760.7

Note: Parentheses indicate negative numbers. Source: Same as table 4-4 (annex 1, table 16).

a. Family labor is valued at its opportunity cost (see the discussion of the farm budget). The number of work days required is given in table 4-7.
b. Clearing is done by a contractor. It is assumed that forest will be cleared to establish improved pasture and that clearing proceeds at the pace given for incremental improved pasture in table 4-4.
c. Destumping is done by a contractor. Following the land use given in table 4-4, it is assumed that 5 hectares, consisting of the 4 hectares of existing cropland plus the additional hectare to be cultivated in year 2, will be destumped in year 1 and the remaining 2 hectares in year 3.
d. The cost of pasture establishment includes only the purchase of colonial variety grass (Panicum maximum).
e. An open well of 20 meters at 02.5 thousand a meter.
f. It is assumed that, of the equipment listed, farmers will already own items of a total value amounting to 050 thousand (in parentheses).
g. From the purchases in table 4-11 multiplied by the prices in table 4-12, the product then divided by 100 to give the value for a single farm. See text for a discussion of this convention. Normal replacement of death loss and culls is considered an operating cost. h. All heifer purchases are considered investment. The prices are taken from table 4-12. i. The excess over normal death loss and without-project culling for bulls in year 1 is considered investment. For the 100-farm herd, table 4-27 shows 33 replacement bulls will

Thus, the heifers purchased are included in the investment tabulation, as are the excess bulls culled in year 1. The work oxen purchased in year 1 are clearly an investment. In years 2 through 20, oxen purchased are to replace animals lost through death and culling; thus, these purchases are considered as operating expenditure. The amounts for the livestock investment are obtained by taking the numbers of animals given in table 4-11, multiplying by the prices in table 4-12, and then dividing by 100 to obtain the amount from a single farm. This is in line with the convention recommended in the discussion of the herd composition, purchases, and sales. (The sale of replaced livestock, such as indigenous cows sold because improved cows are purchased, is better treated as a "negative investment" and not as a benefit.)

In the investment cost tabulation, allowance would be made for any hired labor used for investment purposes. In the Paraguay example, none is used because the clearing and destumping are assumed to be done by contractors. No allowance is made for family labor devoted to investment. This is because the farm family is the recipient of the incremental net benefit as shown in the farm budget. Thus, the family remuneration is the net income stream. Including it under investment cost would constitute double counting. Note, however, that the family does contribute some investment in the Paraguayan example. The fencing and pasture establishment, for instance, are done by family labor. The demand for family labor for investment is accounted for under the labor requirement in tables 4-6 and 4-7.

OPERATING EXPENDITURE

The operating expenditure is given for crops, livestock, and equipment for the Paraguay pattern farm in table 4-16. (The term "expenditure," rather than the more common "cost," is used here because operating cost implies an element of depreciation not included when the farm investment analysis is laid out in accord with the principles of discounted cash flow analysis.) Although unit expenditure per hectare is given in the table, it could have been tabulated instead from the farm-gate prices in table 4-12 on a price-per-unit basis, with the amounts needed for a hectare listed in the table for operating expenditure. This would have been less convenient but more revealing.

For livestock, replacement of normal death loss and without-project culling are considered operating expenditures. As with the investment cost, they are obtained by taking the purchases from table 4-11, multiplying by the farm-gate prices in table 4-12, then dividing by 100 to obtain the value for a single farm. The operating expenditure for minerals, vaccines, and the like is based on the animal units in the herd at the beginning of the year. The cost of pasture maintenance is estimated on be purchased in year 1. Of these, 3 are to replace death loss, and 15 represent the normal culling as practiced without the project. The additional 15 bulls culled in year 1 are considered investment. Their value is divided by 100 to give the value for a single farm of ^4.5 thousand {[(33 - 3 - 15) x 30] - 100= 4.5}.

j. Work oxen purchased in year 1 are considered investment.

Table 4-16. Operating Expenditure, 20-Hectare Mixed Farm, Paraguay Project

Product and operations	Expendi-ture/ hectare	Without project			With project						
		1-2	3-5	6-20	1	2	3	4	5	6	7-20
Crops											
Maize [b]	0	0 0	0	0	0	0	0	0	0	0	0
Manioc[b]	0	0 0	0	0	0	0	0	0	0	0	0
Beans [b]	0	0 0	0	0	0	0	0	0	0	0	0
Cotton											
Hired labor`	-	0 0	0	0	0	0	0	4.5	8.1	16.8	17.4
Seed [d]	0.8	1.6 1.6	1.6	1.6	1.6	1.6	1.6	1.8	2.0	2.4	2.4
Pesticides[d]	4.6	9.2 9.2	9.2	9.2	9.2	9.2	9.2	10.1	11.5	13.8	13.8
Total cotton		10.8 10.8	10.8	10.8	10.8	10.8	10.8	16.4	21.6	33.0	33.6
Soybeans											
Hired labor`	-	- -	-	-	-	0	0	2.1	4.5	9.3	9.6
Seed [d]	2.8	- -	-	-	-	2.8	2.8	6.2	7.0	8.4	8.4
Pesticides [d]	1.5	- -	-	-	-	1.5	1.5	3.3	3.8	4.5	4.5
Fertilizer [d]	8.0	- -	-	-	-	8.0	8.0	17.6	20.0	24.0	24.0
Threshing'	-	- -	-	-	-	2.8	2.8	7.0	8.0	10.8	10.8
Total soybeans		- -	-	-	-	15.1	15.1	36.2	43.3	57.0	57.3

Sunflower											
Hired labor`	-	- -	-	-	-	0	0	0	0.3	0.6	1.2
Seed [d]	0.6	- -	-	-	-	1.2	1.2	1.3	1.5	1.8	1.8
Pesticides [d]	1.2	- -	-	-	-	2.4	2.4	2.6	3.0	3.6	3.6
Threshing'	-	- -	-	-	-	0	3.6	4.0	4.8	6.0	7.2
Total sunflower		- -	-	-	-	3.6	7.2	7.9	9.6	12.0	13.8
Total crops		10.8	10.8	10.8	10.8	29.5	33.1	60.5	74.5	102.0	104.7
Livestock											
Minerals, vaccines, etc r	-	6.8	6.8	6.8	6.8	8.6	10.0	11.4	12.3	12.6	12.5
Improved pasturee	1.0	-	-	-	0	3.5	7.0	10.5	10.5	10.5	10.5
Replacement purchases [h]											
Bulls'	-	5.4	5.8	6.0	5.4	6.0	6.5	6.5	6.5	6.7	6.7
Work oxen'	-	-	-	-	0	13.3	13.6	13.6	13.6	14.1	14.1
Total livestock		12.2	12.6	12.8	12.2	31.4	37.1	42.0	42.9	43.9	43.8
Equipment											
Operation and mainte-nance [k]	-	2.5	2.5	2.5	2.5	10.3	10.3	10.3	10.3	10.3	10.3
Total equipment		2.5	2.5	2.5	2.5	10.3	10.3	10.3	10.3	10.3	10.3
Total operating expendi-ture		25.5	25.9	26.1	25.5	71.2	80.5	112.8	127.7	156.2	158.8

Source: Calculated from other tables as noted.

a. Family labor is valued at its opportunity cost (see the discussion of the farm budget). The number of work days required is given in table 4-7.

b. Assumes no cash expenditure needed for production.

c. From table 4-8 multiplied by the 0300 a day shown in table 4-12. For sunflower, table 4-8 allocates labor according to the labor requirement in table 4-7 for the year of planting. See note c in table 4-7.

d. From the areas in table 4-4 times the unit cost given. For sunflower, seed and pesticide costs are based on the year of planting.

e. From production in table 4-10 multiplied by a threshing cost of 02 thousand per ton.

f. At 0500 an animal unit multiplied by the animal units of herd pasture requirement in table 4-11 at the beginning of the year, the product then divided by 100 to give the value for a single farm.

g. Maintenance; calculated on the basis of improved pasture established in previous years as shown in table 4-4.

h. From the purchases in table 4-11 multiplied by the prices in table 4-12, the product then divided by 100 to give the value for a single farm. See text for a discussion of this convention. Normal replacement of death loss and culls is considered an operating cost.

i. The normal death loss and without-project culling for bulls in year 1 is considered operating expenditure. For the 100-farm herd, table 4-27 shows that 33 replacement bulls will be purchased in year 1. Of these, 3 are to replace death loss, and 15 represent the normal culling as practiced without the project, so all may be considered an operating expenditure. The value of the 18 replacement animals is divided by 100 to give the value for a single farm of 05.4 thousand (18 x 30 - 100 = 5.4). The additional 15 bulls culled in year 1 are considered investment. For years 2 through 20, all bull purchases are considered replacements and thus operating expenditure.

j. Work oxen purchased to replace death loss and culls from years 2 through 20 are considered operating expenditure. Work oxen purchased in year 1 are considered investment.

k. Operation and maintenance cost of equipment is taken to be 5 percent of the investment cost beginning the year after acquisition. It is assumed that without the project the farm has 050 thousand of equipment and thus an annual equipment, operation, and maintenance expense of 02.5 thousand (50 x 0.05 = 2.5). With the project, this expense continues, plus the maintenance of the incremental 0 156 thousand worth of equipment purchased in year 1 as shown in table 4-15, giving a total of 010.3 thousand [2.5 + (156 x 0.05) _ 10.3].

the basis of improved pasture established as of the end of the previous year.

Expenditure for operation and maintenance of equipment is taken to be 5 percent of the initial investment cost beginning the year after acquisition. Expenditure for operation and maintenance of equipment, such as that for pumps, is often included in the operating expenditure of the crop for which the equipment is used. When it is not, as in this example, then it must be shown separately.

The operating expenditure does not include a separate entry for family labor or for land. Rather, these are valued at their opportunity cost by the approach taken in designing the farm budget. (Opportunity cost was defined early in chapter 3, in the section "Prices Reflect Value.") We will return to a discussion of how this is accomplished after we have discussed the farm budget, below.

INCREMENTAL WORKING CAPITAL

. The incremental working capital for the Paraguay pattern farm is given in table 4-17. As noted in the discussion of the accounting convention adopted for farm investment analysis and in table 4-3, the incremental working capital is derived from the information on total operating expenditure in table 4-16 by taking some proportion of the incremental operating expenditure for the following year. To simplify the calculation, it is assumed that the Paraguay pattern farm is predominantly a one-season, annual crop farm. Referring to table 4-3, we note the incremental working capital as a percentage of incremental operating expenditure for one season annual crops ranges between 80 and 100 percent. The incremental working capital needed, then, may be taken at the midpoint of the range, or 90 percent of the incremental operating expenditure in the following year. In year 2, for example, the

Table 4-17. Incremental Working Capital, 20-Hectare Mixed Farm, Paraguay Project

	Project year								
Item	1	2	3	4	5	6	7	8-20	Total

Total operating									
expenditure'	25.5	71.2	80.5	112.8	127.7	156.2	158.8	158.8	-
Incremental operating									
expenditure	-	45.7	9.3	32.3	14.9	28.5	2.6	0	133.3
Incremental working									
capital'	41.1	8.4	29.1	13.4	25.6	2.3	0	0	119.9

Source: Calculated from tables 4-3 and 4-16.

a. From table 4-16.

b. Taken to be 90 percent of the incremental operating expenditure in the following year. For year 1, for example, this comes to 041.1 thousand [(71 - 25.2) x 0.9 = 41.1]. This is based on the recommendation that incremental working capital be a percentage of incremental operating expenditure as given in table 4-3. For purposes of this calculation, it is taken that the model farm is dominantly a one-season, annual crop farm, even though there is a second crop of sunflower and there is a livestock enterprise. Accepting this assumption somewhat overstates the incremental working capital needed.

incremental operating expenditure is 045.7 thousand (71.2 - 25.5 = 45.7) and the incremental working capital in year 1, which is 90 percent of the incremental operating expenditure in the following year, is thus 041.1 thousand (45.7 x 0.9 = 41.1). This simplification somewhat overstates the working capital needed. Note that by totaling the incremental working capital year by year we obtain the 0119.9 thousand residual incremental working capital shown in table 4-14.

Had we wished to make a more precise estimate of the incremental working capital, we could have calculated the amount needed for each category of operating expenditure as given in table 4-16. For crops, we could have taken from table 4-3 the same 90 percent estimate we accepted in our simplification. Taking year 5 as an illustration, the incremental working capital for crops would have been 024.8 thousand [(102.0 - 74.5) x 0.9 = 24.8]. For livestock, we might have accepted 30 percent from the recommended range of 20 to 40 percent in table 4-3. Since the without-project working capital will also increase during the life of the project, the computation of the incremental working capital is somewhat more complicated for livestock than for crops. The without-project incremental operating expenditure must be subtracted from the with-project incremental operating expenditure. This is a minor adjustment and might have been ignored. Taking year 5 as an illustration again, the incremental working capital for livestock would be 00.2 thousand ([(43.9 - 42.9) - (12.8 - 12.6)] x 0.3 = 0.2}. For equipment, we would have taken the full incremental operating expenditure; this, however, does not increase between years 5 and 6 and so is zero (10.3 - 10.3 = 0). Adding the combined incremental working capital for all three categories, we reach an incremental working capital for the farm in year 5 of 025.0 thousand (24.8 + 0.2 + 0 = 25.0). This compares with the estimate of incremental working capital of 025.6 thousand that our simplified calculation in table 4-17 gave us for year 5.

Farm Budget

With the pattern farm resource use, production, and inputs known, the analyst may proceed to draw up the farm budget. When a farm budget for project analysis is prepared, the objective is an estimate of the incremental net benefit arising on the farm as a result of the project. Clear layout of the incremental net benefit is the main reason for the particular format adopted here and illustrated in tables 4-18 through 4-20 for the farm budget of the Paraguay project.

The analyst first calculates the net benefit without the project as shown in table 4-18. The overall format of the pattern farm budget can be seen in the with-project farm budget shown in table 4-19. If we take the *inflow* received on the farm year by year and subtract the *outflow,* we have the stream for *net benefit before financing.* This entry tells what the farm will earn without consideration of any effects of financing. It includes both the value of the crop and livestock production sold off the farm and the value of home-consumed production. Next we subtract the without-

Table *4-18. Without-Project Farm Budget, 20-Hectare Mixed Farm, Paraguay Project* (thousands of G)

Item	*Project year 1*	*2*	*3-5*	*6-20*
Inflow				
Gross value of production[a]	247.7	249.6	254.3	256.2
Total	247.7	249.6	254.3	256.2
Outflow				
Operating expenditure[b]	25.5	25.5	25.9	26.1
Other				
Tax on cattle sale[c]	2.3	2.3	2.3	2.3
Total	27.8	27.8	28.2	28.4
Net benefit before financing[d]	219.9	221.8	226.1	227.8

Source: Calculated from other tables as noted. a. From table 4-13.
b. From table 4-16.

c. A tax of 0800 is paid on each animal sold. The amount is calculated by multiplying the total sales given in table 4-11 by the tax and dividing the result by 100 to obtain the amount for each farm.
d. No financing would be received without the project.

project net benefit (table *4-18)* to obtain the incremental net benefit before financing. In many projects, the without-project incremental net benefit is assumed to remain constant throughout the life of the project, and a without-project column is inserted before the columns for the project years. This constant without-project amount is then subtracted from the net benefit before financing in each project year to obtain the incremental net benefit before financing. In the Paraguay example, the without-project net benefit before financing changes during the life of the project, so this approach cannot be used. Instead, a separate figure for without-project net benefit before financing is calculated as shown in table *4-18;* this figure has been entered in the with-project farm budget in table *4-19.*

Note that in the early years of the with-project farm budget the in-cremental net benefit before financing will generally be negative as investment is undertaken. Later, when the stream turns positive, it is a measurement of the additional amount that the farm will produce as a result of the project. The stream of the incremental net benefit before financing is the cash flow as defined in chapter *9.* When it is discounted, again as discussed in chapter *9,* it becomes the basis for such measure-ments of project worth as the *net present worth of all resources engaged,* the *financial rate of return to all resources engaged,* or the *net benefit-investment ratio of all resources engaged.* Deriving measurements of project worth based on all resources engaged, whether the resources come from the farmer's own contribution or a lending institution, is commonly done to judge the financial viability of the investment on the farm. It is especially favored by analysts who have accounting experience.

If we eliminate transfer payments and value entries at efficiency prices as discussed in chapter 7, the incremental net benefit before financing is the incremental contribution to the national income. Aggregated to the project level, it becomes the basis for the benefit stream for the project and for calculating the net present worth, the economic rate of return, or the net benefit-investment ratio for the project-that is, the return which the project contributes to the economy as a whole.

If we proceed to look at the financing available with the project-after we allow for loan *receipts* and *debt service* including interest payments and repayment of principal, which together give the net financing-we reach the net *benefit after* financing. This is also called the farm family net benefit, since it is the amount that the family has to live on for the year. Maximizing the, net benefit after financing is taken to be the objective of the farm family; it is thus defined consistently with the objectives laid out in chapter 2. This is a most important estimate because, obviously, it directly affects the incentive to the farm family to participate in the project.

The difference between what the family would receive without the project and the net benefit after financing is the incremental net *benefit* a *fter* financing. This is the additional amount the family would receive by participating in the proposed project over and above what it would receive without the project. Note that, as in the Paraguayan example, the incremental net benefit generally will be negative in the first few years if the farmer must invest some of his own resources to participate in the project. The incremental net benefit (or incremental farm family net benefit) is, in effect, the direct incentive to the family to participate in the project. It is the cash flow seen from the point of view of the farmer, as defined in chapter 9. Discounted, it will give the financial rate of *return to the* farmer's own *resources* if he has invested any of his own capital in the project. Discounting the net benefit after financing and dividing by the discounted net benefit after financing without the project yields the net *benefit increase,* a measure of farmer incentive discussed in more detail in the section devoted to that topic later in this chapter.

It is extremely convenient to separate the financing transactions in the farm budget, as is illustrated in the Paraguay example. By leaving financ-ing to a later part of the table, we can concentrate on what the farm will produce in arriving at the incremental net benefit before financing. This gives a direct estimate of how much total investment will be needed from all sources for the pattern farm. The incremental net benefit before financing is derived directly, and this makes it convenient to calculate the measures of project worth based on all resources engaged. This format directly provides a basis for aggregation and is also the starting point for the economic analysis discussed in chapter 7. Grouping the financing transactions is convenient if there is a credit element in the project, as there so often is, because it permits looking at the credit

Table *4-19. Farm Budget, 20-Hectare Mixed Farm, Paraguay Project* (thousands of 0)

Item	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8-11*	*12*	*13*	*14-19*	*20*
						Inflow						
Gross value of production[a]												
Crops	187.8	237.0	289.2	340.7	387.4	485.3	501.5	501.5	501.5	501.5	501.5	501.5
Livestock	51.4	63.5	73.0	85.9	115.3	135.2	133.1	133.1	133.1	133.1	133.1	133.1
Off-farm income	-	-	-	-	-	-	-	-	-	-	-	-
Incremental residual value[b]	-	-	-	-	-	-	-	-	-	-	-	430.6
Total inflow	239.2	300.5	362.2	426.6	502.7	620.5	634.6	634.6	634.6	634.6	634.6	1,065.2
						Outflow						
Investment[c]	523.6	110.6	126.5	0	0	0	0	0	0	0	0	0
Incremental working capital[d]	41.1	8.4	29.1	13.4	25.6	2.3	0	0	0	0	0	0
Operating expenditures	25.5	71.2	80.5	112.8	127.7	156.2	158.8	158.8	158.8	158.8	158.8	158.8
Other												
Tax on cattle sale[f]	1.9	2.4	2.6	3.1	4.2	4.7	4.6	4.6	4.6	4.6	4.6	4.6
Total outflow	592.1	192.6	238.7	129.3	157.5	163.2	163.4	163.4	163.4	163.4	163.4	163.4
					Net benefit before financing							

Total	(352.9)	107.9	123.5	297.3	345.2	457.3	471.2	471.2	471.2	471.2	471.2	901.8
Without projects	219.9	221.8	226.1	226.1	226.1	227.8	227.8	227.8	227.8	227.8	227.8	227.8
Incremental	(572.8)	(113.9)	(102.6)	71.2	119.1	229.5	243.4	243.4	243.4	243.4	243.4	674.0
Financing[h]												
Loan receipts	508.2	107.1	140.0		0 0	0	0	0	0	0		00
Debt service	-	66.1	80.0	98.2	98.2	159.2	172.1	188.9	61.8	35.0		00
Net financing	508.2	41.0	60.0	(98.2)	(98.2)	(159.2)	(172.1)	(188.9)	(61.8)	(35.0)		00
Net benefit after financing												
Total	155.3	148.9	183.5	199.1	247.0	298.1	299.1	282.3	409.4	436.2	471.2	901.8
Without projecte	219.9	221.8	226.1	226.1	226.1	227.8	227.8	227.8	227.8	227.8	227.8	227.8
Incremental	(64.6)	(72.9)	(42.6)	(27.0)	20.9	70.3	71.3	54.5	181.6	208.4	243.4	674.0
Cash position												
Net benefit after financing	155.3	148.9	183.5	199.1	247.0	298.1	299.1	282.3	409.4	436.2	471.2	901.8
Less home-consumed production'	50.0	50.0	50.0	50.0	50.0	40.2	44.4	44.4	44.4	44.4	44.4	44.4
Cash surplus (or deficit)	105.3	98.9	133.5	149.1	197.0	257.9	254.7	237.9	365.0	391.8	426.8	857.4

Net present worth at 12 percent of all resources engaged = 0416 thousand' *Financial rate of return to all resources engaged* = 18 percent' *Net benefit-investment ratio at 12 percent of all resources engaged* = 01,091.6 - 0675.4 = 1.621 *Financial rate of return to the farmer's own resources* = 26 percent k *Net benefit increase* = [(02,071.7 - 01,686.4) - 1] x 100 = 23 percent'

Source: Calculated from other tables as noted. a. From table 4-13.

b. From table 4-14. c. From table 4-15. d. From table 4-17.

e. From table 4-16. If labor had been hired and paid in kind and this had not been included in the operating expenditure table, it would be shown here under operating expenditure as a separate line.

f. A tax of 0800 is paid on each animal sold. The amount is calculated by multiplying the total sales given in table 4-11 by the tax and dividing the result by 100 to obtain the amount for each farm.

g. From table 4-18. No financing would be received without the project. h. The farmer receives a loan from the Paraguayan National Development Bank for 90 percent of the investment cost and for 90 percent of the in-cremental working capital during the investment period, which is years I through 3. The loan is for a ten-year period, with a four-year grace period during which interest is paid. The loan received each year is treated as a separate transaction. Thus, for the loan received at the end of year 1, the grace period is for years 2 through 5 and the principal of the loan is repaid during years 6 through 11. The interest rate is 13 percent. See table 4-24 for details of the computation.

i. Assumes that the family would eat all of the maize and beans and part of the manioc in years 1 through 5. From year 6 onward it is assumed that the family will consume all of the maize and manioc.

j. Calculated on the basis of the incremental net benefit before financing. For details about the method of computation, see chapter 9.

k. Calculated on the basis of the incremental net benefit after financing. 1. The net benefit increase is the present worth of the incremental net benefit after financing with the project divided by the present worth of the net benefit after financing without the project; expressed in percentage. See text for a discussion of this measure. For details about the method of the present worth computation, see chapter 9.

transaction separately. The timing of the loan receipts, the timing of the debt service, and the net financing can all be determined easily by simple inspection. Then, by examining the incremental net benefit after financ-ing, an assessment can be made about the amount of credit a farmer will need to participate and when he should repay it. With the incremental net benefit after financing now available, it is a simple matter to discount it to determine the financial rate of return to the farmer's own resources.

Of the individual entries included under the inflow in table 4-19, the first is the gross value of production, which is derived directly from table 4-13. This entry includes only that production available for use off the farm or by the farm family itself; it does not include any production used as an intermediate product on the farm. In particular, it does not include feed produced and fed to animals on the farm. Note the gross value of production includes any production consumed at home; it is not, there-fore, the gross sales. In the Paraguayan example, the family will consume most of the maize, manioc, and beans it produces, as noted in the last section of the farm budget. If we fail to include the value of home-consumed production as part of the gross value of production, we will understate the attractiveness to the farmer of participating in the proj-ect. Furthermore, when we recast the budget to reflect economic values we will understate the true contribution of the project to the national income. In turn, this will make the measures of project worth of those projects in which a high proportion of the incremental production is to be consumed by the farm family look relatively less attractive than those of projects in which a high proportion of the incremental production is to be sold. We may thus penalize many of the very projects that provide the greatest benefit to the most disadvantaged farmers.

It is important that any off-farm income the farmer may earn be included in the budget. Hence, a dummy line has been included in table 4-19 even though there is no off-farm income involved in the Paraguay example. As we will discuss in detail in the next section, by including off-farm income in the budget we are automatically able to value family labor at its opportunity cost. This avoids trying to impute separately an appropriate wage for family labor.

Two other items may enter under the inflow that were not needed in the Paraguay example. The first is direct grants received by the farmer. Subsidies that benefit the farmer by lowering the cost of an input or by increasing the price he receives for his production would not be entered here. Instead, they would be accounted for by entering the subsidized market price in the account. Later, in the economic analysis, these items would have to be revalued to reflect the subsidy.

A second entry that might appear as an inflow in a farm budget but that is not needed in the Paraguay example is the rental value of the farm house. In most projects, no investment in housing is made, and the rental value remains unchanged with or without the project. As a result, the rental value has no effect on the incremental net benefit and so is gener-ally omitted. If, however, the cost of the project has included housing, as might be the case in a settlement project, then the rental value of that housing is a benefit for which allowance must be made. In most instances the rental value will be imputed and-as with all imputed values-great care must be exercised in determining it

.

The last of the inflow items in table 4-19 is the *incremental residual value.* This is derived for the Paraguayan example from table 4-14. First among the elements of the *outflow is* the on-farm *investment.* Note that the total on-farm investment is included here, not just that propor-tion the farmer is expected to pay from his own funds. The investment the farmer must make himself as of the end of the year will appear as a negative *incremental net benefit after financing* at the bottom of the table. For most farm investment analyses, the major items of investment would be detailed in a supporting table such as table 4-15, since the focus so often is upon some on-farm investment. In projects where the major investment is made off the farm, as might be the case in irrigation, there may be no substantial on-farm investment.

The next outflow is the *incremental working capital,* taken from table 4-17. As noted earlier in this chapter in the discussion of the accounting convention, the incremental working capital is calculated as some proportion of the increase or decrease in operating expenditure the follow-ing year. It reflects, of course, the need to have on hand at the beginning of the season sufficient funds to finance inputs for crop and livestock production.

The next entry for outflow is the *operating expenditure,* taken from table 4-16. If hired labor paid in kind were omitted from table 4-16 (which some analysts prefer to treat as a list of cash expenditures), then a separate entry would have to be included under the *operating expenditure.*

Finally, an entry is made for *other* outflows. In the Paraguayan pattern farm budget, the only other outflow is for a tax on cattle sales. A tax on land, however, might also be found under this entry, as might general overhead, a betterment levy, or a capital recovery charge for an irriga-tion project. An income tax would usually not be shown here; it is uncommon for a small farmer to have to pay income tax, and, in any event, it is generally considered that income tax is levied against the farmer as an individual rather than against the farm as such. (This, of course, is in contrast to corporate income taxes, which would be shown if levied; see chapter 5 for a discussion of accounts for agricultural process-ing industries.) In general, indirect taxes such as sales taxes or tariffs on imported items will be included in the price of inputs; this works well for financial analysis, but it may lead to complications when the economic values are being estimated. The total inflow less the total outflow gives the *net benefit before financing.*

The section of table 4-19 devoted to *financing* begins with the projec-tion of the *loan receipts* the farmer may expect if he participates in the project. Loan receipts are commonly divided into short-term and medium- or long-term. In the Paraguay example, only medium-term loans are to be received. Loans are entered in the year they are to be received.

Debt service-the payment of interest and repayment of principal-follows. Usually it, too, will be disaggregated by the length of the loan maturity. Interest and principal repayments are often shown as a single entry, although sometimes interest payments and the principal repay-ment are shown separately. The details of how to calculate interest payments and principal repayments are discussed in the section "Com-puting Debt Service" later in this chapter.

The debt service is subtracted from the loan receipts to reach the *net financing,* which is shown with an indication of whether it is positive or negative. In the Paraguay example, in years 1 through 3 the loan receipts exceed the debt service, so the net financing is positive; in years 4 through 13, however, debt service exceeds the loan receipts, and so the net financ-ing is negative.

The net financing subtracted from (or added to, as appropriate) the net benefit before financing gives the *net benefit a fter financing,* also called the farm family net benefit. As noted, this is the amount the family has to live on with the project and is most important for judging incentive effects of the project. It is probably an estimate of this amount that most farmers make when they decide whether to participate in a project, although no doubt they arrive at it by a less formal means.

If we subtract the net benefit after financing without the project from the net benefit after financing for each project year, we arrive at the *incremental net benefit after financing,* or incremental farm family net benefit. This is the same incremental net benefit or cash flow defined in chapter 9. It represents an undifferentiated return of and to the farmer's capital; discounted, it gives the financial rate of return to the farmer's own resources. The incremental net benefit after financing also provides us with another basis for a judgment about incentive effects. Would a farmer be willing to shoulder the additional risk and effort needed to participate in the project if he can expect this kind of incremental income?

Because home-consumed production is included in the farm budget, if any high proportion of the incremental production is expected to be consumed in the farm household, it is desirable to have a section on the *cash position* to determine whether the farmer will have the cash he needs to purchase modern inputs and to meet his credit obligations. (This is the point at which a bit of funds flow analysis is mixed in with the farm investment analysis.) One means is to calculate a separate cash budget as Brown suggests (1979, pp. 25-30). Another means is shown at the bottom of table 4-19. Here, a line is added to subtract the value of *home-consumed production* from the *net benefit after financing.* The remainder is the *cash surplus (or deficit).* If there is a deficit, it must be made up from family savings or other sources if the farmer is not to fall behind in his invest-ment plan or to default on his credit obligations. Alternatively, we may wish to adjust the amount of short-term credit extended or alter the conditions of long-term credit to avoid the cash deficit.

The farm budget presented in table 4-19 assumes that the real burden of debt service will continue throughout the life of the loan the farmer receives. As in most countries, in the Paraguay project the lending terms to farmers call for repayment in nominal-that is, money-terms. In-terest is stated at a given rate, and the nominal amount of principal repayment is agreed upon. If, however, a country experiences inflation that reduces the real value of money over time, the result is that farmers whose debt service payments are fixed in money terms have a declining real burden of debt service. Some countries try to adjust for this by indexing loans so that the nominal amount a farmer pays changes to maintain the same real burden of debt service, but most do not.

If Paraguay were expected to experience inflation, then the farm budget would be a more realistic indicator of income and incentive if it reflected the declining real burden of debt service. Predicting future inflation rates is difficult at the very least (and may lead to political complications for analysts in public agencies if the government has adopted a strong anti-inflation program). Past experience is some indica-tion of what future inflation may be. In 1977 the wholesale price index in Paraguay rose by 8 percent, so that rate might be accepted as an estimate of future inflation. If we assume constant inflation of 8 percent during the life of the loan, then the debt service each year will be reduced by dividing it by 1 plus the rate of inflation stated in decimal terms to reflect the declining real burden. The farm budget for the Paraguay example is recast in table 4-20 to incorporate this assumption. The table projects that the real value of the loan receipts in years 2 and 3 will remain the same-which is to say that their nominal value will increase by the amount of inflation. This is perhaps an unrealistic assumption in many countries. If so, not only the debt service but the real value of the loan receipts might be reduced by the amount of the inflation, and the farmer would have to invest more of his own resources to keep his investment program on schedule. (The details about how the loan receipts and debt service were calculated are given in the section "Computing Debt Ser-vice" and in table 4-26, below.)

The recast farm budget in table 4-20 begins with the net benefit before financing, which is the same as that in table 4-19 since table 4-19 is cast in constant terms and the relative prices are correct. (The reader will recall that the prices in table 4-12, which formed one of the bases for table 4-19, were varied to allow for changing relative values.) Since all prices in both tables 4-19 and 4-20 maintain the same relation to each other or have been changed to reflect changing relations, the tables are, in effect, cast in terms of the value of the guarani in project year 1. The terms of the loan to the farmer from the Paraguayan National Development Bank are the same as those outlined in table 4-19 and are set in nominal terms. Comparing the debt service line in tables 4-19 and 4-20 shows the effect of assuming a declining real burden of debt service, as does a comparison between the two lines for the incremental net benefit after financing.

Recasting the farm budget to reflect the declining real burden of debt service shows that the real return to the farmer for his own resources would rise from the 26 percent estimated in table 4-19 to 34 percent. The net benefit increase (discussed later in this chapter) would rise from 23 percent to 35 percent. Both increases, of course, reflect the declining real burden of the debt service.

Casting the farm budget to reflect the declining real burden of debt service that occurs in inflationary circumstances certainly is more realistic than assuming a constant burden. It probably also will lead to a better

Table *4-20. Farm Budget Assuming Declining Real Burden of Debt Service, 20-Hectare Mixed Farm, Paraguay Project*
(thousands of Q)

Project year

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14-19	20
Net benefit before financing'	(359.2)	107.9	123.5	297.3	345.2	457.3	471.2	471.2	471.2	471.2	471.2	471.2	471.2	471.2	901.8
Financing [b]	508.2	107.1	140.0	0	0	0	0	0	0	0	0	0	0	0	0

Loan receipts'															
Debt service`	-	61.2	69.6	81.3	75.2	111.1	111.6	114.9	106.3	98.4	91.1	29.8	16.2	0	0
Net financing	508.2	45.9	70.4	(81.3)	(75.2)	(111.1)	(111.6)	(114.9)	(106.3)	(98.4)	(91.1)	(29.8)	(16.2)	0	0
Net benefit after financing															
Total	149.0	153.8	193.9	216.0	270.0	346.2	359.6	356.3	364.9	372.8	380.1	441.4	455.0	471.2	901.8
Without project'	219.9	221.8	226.1	226.1	226.1	227.8	227.8	227.8	227.8	227.8	227.8	227.8	227.8	227.8	227.8
Incremental	(70.9)	(68.0)	(32.2)	(10.1)	43.9	118.4	131.8	128.5	137.1	145.0	152.3	213.6	227.2	243.4	674.0
Cash position															
Net benefit after financing	149.0	153.8	193.9	216.0	270.0	346.2	359.6	356.3	364.9	372.8	380.1	441.4	455.0	471.2	901.8
Less home-consumed production a	50.0	50.0	50.0	50.0	50.0	40.2	44.4	44.4	44.4	44.4	44.4	44.4	44.4	44.4	44.4
Cash surplus (or deficit)	99.0	103.8	143.9	166.0	220.0	306.0	315.2	311.9	320.5	328.4	335.7	397.0	410.6	426.8	857.4

Net present worth at 12 percent of all resources engaged = 0416 thousand[s] *Financial rate of return to all resources engaged* = 18 percent[s]
Net benefit-investment ratio at 12 percent of all resources engaged = 01,091.6 - 0675.4 = 1.62d *Financial rate of return to the farmer's own resources* = 34 percent' *Net benefit increase* = [(02,282.3 - 01,686.4) - 1] x 100 = 35 percent'

Source: Calculated from other tables as noted. a. From table 4-19.

b. The terms and conditions of the financing are assumed to be the same as those in table 4-19, note h. It is assumed that there will be a constant inflation of 8 percent during the term of the loans. The table is stated in real terms in constant guaranis of project year 1 (except for the nominal terms for the loan receipts). Since debt service is denominated in nominal (money) terms, the real burden declines each year by the amount of inflation. Loan receipts are stated in real terms under the entry for loan receipts, and the nominal amounts for the second and third-year loans are given. The nominal amount is increased by the amount of inflation.

c. For details of the computation, see the section "Computing Debt Service" and table 4-26 later in this chapter.

d. Calculated on the basis of the incremental net benefit before financing. (Note that this is the same value as in table 4-19). For details about the method of computation, see chapter 9.

e. Calculated on the basis of the incremental net benefit after financing.

f. The net benefit increase is the present worth of the incremental net benefit after financing with the project divided by the present worth of the net benefit after financing without the project expressed in percentage. See text for a discussion of this measurement. For details about the method of computing the present worth, see chapter 9.

estimate of the real attractiveness of a project to farmers, since most farmers will have some sense of the effect of inflation on nominal values. Except for the additional computations needed to project the farm budget, such an approach creates no analytical complications. Project aggregations can simply be based on the farm budgets that assume a declining real burden of debt service, just as they would be if the budget assumed that the burden of the debt service would remain constant and that the loan would be indexed. Of course, allowing for a declining real burden of debt service in the farm budget would not change the economic rate of return of a project, since that is based on the net benefit before financing valued in economic terms (discussed in chapter 7).

COST OF FAMILY LABOR. A common conceptual problem met when pre-paring farm investment analyses is how to determine the cost of family labor. The general principle, as with most questions of valuation, is to value family labor at its opportunity cost; that is, the benefit the family must forgo to participate in the project. This is done simply and more or less automatically if the farm budget format recommended here is followed.

This method has the tremendous practical advantage that the cost of family labor need not be estimated directly. Rather, the cost of family labor is taken to be what the family could earn in its next most remunera-tive alternative without the project. To accomplish this, the farm budget must compare the with-project sit-uation with the without-project situa-tion, and the off-farm labor income must be included in the budget-at least if there is to be any change in the amount earned from off-farm labor. The cost of the family labor needed to adopt the with-project cropping pattern, then, is the labor income in the without-project situa-tion that must be given up. If the number of days of off-farm work must be reduced for the farm family to participate in the project, to that extent the cost of incremental family labor is the off-farm wage. If the with-project cropping pattern calls for a shift of family labor from one produc-tion activity on the farm to another, the cost of the labor shifted is implicitly set at the labor income forgone in the without-project activity. Finally, if more total family labor is called for in the with-project crop-ping pattern than in the pat-tern without the project, as is the case in the Paraguay example, this additional labor is implicitly priced at an oppor-tunity cost of zero, since no income must be forgone to use the labor in the with-project cropping pattern. This assumes, in effect, that the family would have worked more days of the year in the without-project situa-tion had there been suitable opportunities available either through addi-tional farm work or off the farm. Any incremental labor needed in the with-project cropping pattern compared with the without-project crop-ping pattern plus off-farm employment is assumed to be taken from undesired leisure given up. (Later, when the analyst converts from finan-cial prices to economic values, the off-farm earning would be valued at the appropriate shadow wage.)

without basis without entering the rent separately would be the simplest way to allow for the opportunity cost of land.

If the land is to be purchased, the purchase price would properly be shown as a cost in the financial accounts. Again, however, in converting to efficiency prices for the economic analysis the opportunity cost would be taken as the economic value. As before, simply comparing the situa-tions with and without the project in the economic accounts is generally the most convenient approach and will correctly value the land at its opportunity cost. Sometimes, however, different approaches may be taken in the economic accounts, a topic to which we will return in chapter 7 in the subsection "Step 3. Adjustment for price distortions in non-traded items."

Net Benefit Increase

5. FINANCIAL ANALYSIS OF PROCESSING INDUSTRIES

Agricultural projects requently include processing facilities such as packing sheds, preserving and canning plants, oil extraction mills, rice mills, sugar refineries, and the like. For these agriculturally based industries (or "agroindustries"), we must project and analyze financial statements to judge efficiency, incentive, creditworthiness, and liquidity and to determine the costs and benefits that are to be included in the overall project. Whether such enterprises are publicly or privately owned, there is the same need to analyze their financial structure.

Analyzing and projecting financial statements for these enterprises requires a considerable, specialized expertise that those responsible for agricultural project analysis often do not possess. The purpose of this chapter is thus twofold. First, for those who do not consider themselves experts in financial analysis, it provides an analytical pattern to apply to less complex agricultural industries included in their projects. Second, for an accountant or financial analyst, it indicates the kinds of financial information needed for agricultural projects. Then, when a project analyst turns to these specialists for their help, they can adapt the pattern formats in this chapter to develop appropriate financial statements for a particular agricultural project.

The treatment here of these issues is necessarily brief; project analysts may want to consult Upper (1979), a collection of teaching materials that expands many of the elements only summarized here. Much of the following discussion is drawn directly from these materials. Those interested in more detail may also wish to consult a standard accounting textbook such as Niswonger and Fess (1977), which uses the U.S. accounting conventions, or Bigg and Perrins (1971), which uses the British conventions. In the discussion here, we will generally follow the accounting conventions of U.S. practice and note some of the important ways that it differs from British practice. Both conventions, however, are essentially identical; differences are almost entirely limited to conventions of presentation and to a few specialized terms used for accounting concepts.

We will illustrate the kinds of accounts that are appropriate for the financial analysis of a processing enterprise that is a part of an agricultural project with examples adapted from the sugar mill included in the South Nyanza Sugar Project in Kenya. We will reproduce the figures for selected years; the original accounts were projected for sixteen years.

The overall South Nyanza project included establishment of a nucleus sugarcane plantation; development of a network of small farmers, or outgrowers, who would supply additional cane; and a processing component-a sugar mill initially capable of crushing 60,000 tons of cane a year, 90,000 tons of cane after later expansion. The accounts presented contain all the elements necessary for analysis of much simpler enterprises but are also complex enough to be useful as a pattern to be adapted by those with specialized knowledge of financial analysis.

For an agriculturally based industry included in a project, three basic financial statements should be prepared: balance sheets, income statements, and sources-and-uses-of-funds statements. If the project represents an expansion of an existing facility, then these accounts should include historical information for, say, about five years previous to the beginning of the project. Both for enterprises that are to be expanded and new enterprises, these statements would be projected over the life of the project.

The balance sheets give a view of the assets and liabilities of the processing enterprise at the end of each accounting period, which is usually a year-a kind of still photograph of the financial state of the enterprise at a given moment. The income statements summarize the revenues and expenses of the enterprise during each accounting period and give a kind of cinematic picture of activities over time. The sources-and-uses-of-funds statements are a summary of the financial transactions taking place during each accounting period. In essence, they convert the income statement to a cash (or funds) basis. They highlight large transactions, such as the purchase of assets and creation of new obligations (both debt and equity), that appear as changes in the balance sheets for the opening and closing of each period.

On the basis of these financial statements, the project analyst can form a judgment about the efficiency of current operations and about how efficient proposed new facilities are likely to be. He can assess the returns to investors if the project is to be financed by private funds or by accountable public enterprises. The statements may reveal losses that will have to be made up through a subsidy if the enterprise is to remain financially solvent; from them the analyst can examine the creditworthiness and liquidity of the enterprise during the project life as a basis for arranging its financing. In general, the project analyst will make use of three sets of ratios, which are derived from the financial statements and which give him insight to help form his financial judgments-efficiency ratios, income ratios, and creditworthiness ratios.

The financial data essential to analyze any new project are, of course, based on incremental expenses and revenues. The South Nyanza example for our discussion was a new project, and virtually the whole sugar mill was incremental. (There were a few existing assets.) Many projects, however, will entail expansion of existing facilities. In these instances, the analysis centers on incremental growth in the parent enterprise, the situation with and without the expansion that the parent enterprise will carry out. Costs and revenues that would be realized by the parent enterprise whether or not a particular project is undertaken are not considered in the estimate of the incremental contribution. On the one hand, the potential future effects of a proposed project must be isolated from the overall accounts of the parent enterprise. On the other hand, the project analyst will be concerned not only with the financial dimensions of a proposed expansion alone. He must also be satisfied that the parent enterprise is financially able to carry out the expansion, and that may require projecting financial statements for the enterprise as a whole, including the expansion envisioned by the project.

Accounts are kept for operating entities rather than for the persons who own, manage, or are otherwise employed by them. The enterprise represents a group of resources subject to common control. In financial analysis, it is the operating entity that is viewed as controlling the resources and receiving the income. The entity is, in turn, owned by its proprietors or shareholders. The management of the enterprise acts on behalf of the owners, whether private or government.

Accounts for operating enterprises are kept on an accrual basis. That is, revenues are recorded in financial statements for the period in which they are earned, and expenses are recorded in the period incurred, regardless of when the corresponding cash transactions took place. In contrast, cash accounting shows transactions only when cash payments are actually made. Governments generally keep their accounts on a cash basis, as do some small businesses. Public sector enterprises, however, normally follow the accrual principle because it is more useful for managerial decisionmaking.

The most common and generalized categories of items included in the accounts of the South Nyanza project appear in italic type in the text of this chapter. If the analyst takes the italicized items and the illustrative tables as a general pattern and adapts them to the particular project he is working on, he will arrive at a satisfactory account for most simple processing enterprises. Conceptual errors would probably be limited and have little effect on the overall project investment decision, although the analyst may wish to verify his projected financial statements by consulting an accountant. Consultation with a financial analyst early in project preparation will probably be necessary when the financial statements for the processing plant become more complex.

Balance Sheet

The most well-known financial statement is the balance sheet. It is a snapshot of an enterprise at a particular point of time. In the South Nyanza example in table 5-1, the assets of the sugar mill are listed above and its liabilities and equity below. Assets and liabilities are listed according to the U.S. convention of showing the most liquid, or current, first and then progressing through less and less liquid forms to end with fixed assets and long-term liabilities. British usage shows the least liquid first,

Table 5-1. Balance Sheets, Factory Capacity of 90,000 Tons, South Nyanza Suger Ltd.

Item	Project year			
	1	9	10	11
	Assets			
Current assets				
Cash and bank balance	3,323	17,241	69,559	106,234
Accounts receivable-outgrowers	2,952	47,202	48,047	48,471
Inventories				
Nucleus estate standing crop b	3,428	25,546	24,181	22,174
Other inventories`	1,525	7,000	7,000	7,000
Total current assets	11,228	96,989	148,787	183,879
Fixed assets				
Buildings and equipment at cost	34,549	469,736	472,094	479,923
Less accumulated depreciation	(2,872)	(207,498)	(241,560)	(275,741)
Construction in progress	84,437	-	-	-
Net fixed assets	116,114	262,238	230,534	204,182
Other assets	-	-	-	-
Total assets	127,342	359,227	379,321	388,061
	Liabilities and equity			
Liabilities-current				
Accounts payable	-	-	-	-
Short-term loans	-	-	-	-

Table 5-1. Balance Sheets, Factory Capacity of 90,000 Tons, South Nyanza Suger Ltd.

Item	Project year			
	1	9	10	11
Long-term loans-current portion				
World Bank	-	6,563	6,563	6,563
European Investment Bank	-	10,956	10,956	10,956
East African Development Bank	-	2,846	2,846	2,844
Suppliers' credits-current portion				
Suppliers' credit-Germany	-	7,050	7,050	-
Suppliers' credit-India	-	6,381	6,331	-
Taxes payable	-	-	-	-
Total current liabilities	-	33,796	33,746	20,363
Liabilities-long-term				
Long-term loans				
World Bank	-	98,435	91,872	85,309
European Investment Bank	33,400	54,780	43,824	32,868
U.S. Export-Import (Exim) Bank	7,900	-	-	-
East African Development Bank	6,070	5,690	2,844	-
Suppliers' credits				
Suppliers' credit-Germany	17,200	7,050	-	-
Suppliers' credit-India	15,500	6,331	-	-
Total long-term liabilities	80,070	172,286	138,540	118,177
Total liabilities	80,070	206,082	172,286	138,540
Equity				
Share capital	57,000	196,500	196,500	196,500
Retained earnings	(9,728)	(43,355)	10,535	53,021
Total equity	47,272	153,145	207,035	249,521
Total liabilities and equity	127,342	359,227	379,321	388,061

KSh Kenyan shillings.

Note: Parentheses indicate negative numbers.

Source: Adapted from World Bank, "Kenya: Appraisal of the South Nyanza Sugar Project," 1418-KE (Washington, D.C., 1977; restricted circulation), annex 20, table 12.

a. Represents the net value of services and inputs provided to outgrowers (small farm-ers), including company overhead cost allocated to outgrowers.

b. Includes investment in sugarcane (current value less production cost of sugarcane; excludes value of land).

c. Includes spare parts, tools, and operating materials.

working through to the most current. (Also, if assets and liabilities are listed in parallel columns instead of at the top and bottom of a page, U.S. custom is to show assets on the left-hand side, whereas British usage is to put the liabilities on the left.) Assets and liabilities plus equity are defined so that they must always be equal. Thus we have the identity: assets - liabilities + owners' equity. Assets must be owned by the enterprise and be of measurable value. There are three principal kinds of assets: current, fixed, and other. Current assets consist of cash, including checking accounts in a bank; accounts receivable, which are amounts owed to the firm by customers and are expected to be converted into cash in the reasonably near future, usually in less than a year; and inventories intended for rather prompt sale. In the South Nyanza example, the standing crop of sugarcane on the nucleus plantation is treated as an inventory. Fixed assets include durable goods of relatively long life to be used by the enterprise in production of goods and services rather than to be held for sale. Property, plant and equipment, and land are the most common fixed assets. Often, as in the South Nyanza example, buildings

Table 5-2. Income Statement, Factory Capacity 90,000 Tons, South Nyanza

Item	Project year			
	1	9	10	11
Revenue				
Sale of sugar'	-	227,378	244,351	265,487
Sale of molasses b	-	9,194	9,880	10,734
Total revenue	-	236,572	254,231	276,221
Cash operating expenses				
Nucleus estate sugarcane production`	-	11,173	9,657	10,241
Outgrowers' sugarcane purchased	-	72,296	80,532	85,404
Molasses-transport and excise tax'	-	5,412	5,815	6,318
Factory variable cost	-	15,133	16,263	17,670
Factory overhead	-	10,714	10,714	10,714
Total cost of goods sold	-	114,728	122,981	130,347
Gross income (profit)	-	121,844	131,250	145,847
Selling, general, and administrative expenses				

Table 5-2. Income Statement, Factory Capacity 90,000 Tons, South Nyanza

Item	Project year			
	1	9	10	11
General administration	646	7,843	7,843	7,843
Training	37	267	267	267
Research	477	627	627	627
Management fee-nonvariable	1,121	1,210	1,210	1,210
Management fee-variable	-	3,890	4,225	4,886
Total selling, general, andadministrative expenses	2,281	13,837	14,172	14,833
Funds from operations (operating income before depreciation)	(2,281)	108,007	117,078	131,041
Noncash operating expenses				
Depreciation				
Factory, general administration, research and housing assets	748	24,172	24,172	24,172
Nucleus estate and outgrowers' assets	2,124	15,628	18,160	20,125
Other	-	-	-	-
Total noncash operating expenses	2,872	39,800	42,332	44,297
Total operating expenses	5,153	168,365	179,485	189,477
Operating income (profit)	(5,153)	68,207	74,746	86,744
Nonoperating income and expenses				
Interest received	(-)	(4,245)	(4,770)	(5,048)
Interest paid	4,575	19,738	17,008	14,545
Duties and indirect taxes	-	-	-	-
Subsidies	(-)	(-)	(-)	(-)
Total nonoperating expenses	4,575	15,493	12,238	9,497
Income (profit) before income taxes	(9,728)	52,714	62,508	77,247
Income taxes	-	-	8,618	34,761
Net income (profit) after taxes	(9,728)	52,714	53,890	42,486

Source: Same as table 5-1 (annex 20, table 11).

a. Valued at KSh3,050 per ton.

b. Valued at KSh350 per ton f.o.b. Mombasa.

c. Represents total cost of production of sugarcane on the nucleus estate.

d. Value of sugarcane purchased from outgrowers at KSh155 per ton.

e. Includes excise tax of KSh6 per ton and transport charges of KShl0 per ton from factory to dockside in Mombasa.

and equipment at cost are shown at their original cost, and then the accumulated depreciation allowances are deducted. Land, by convention, is never depreciated. In the South Nyanza example, construction in progress is shown separately as a fixed asset. A third kind of asset, called simply other assets, is not needed in the South Nyanza balance sheet. This category would include investments in other companies or long-term securities; deferred expenses, such as start-up expenses for a new project, to be charged over several accounting periods; intangible assets such as patents and trademarks that have no physical existence but are of value to the enterprise; and miscellaneous additional assets peculiar to particular types of enterprises.

Liabilities are the claims against the assets of the enterprise that creditors hold-in other words, the outstanding debts of the enterprise. There are two principal kinds. Current liabilities comprise debts falling due within a year, such as accounts payable, short-term loans, and the current portion of long-term loans and suppliers' credits that must be paid within the coming accounting period. Taxes payable but not yet paid are also a current liability. Long-term liabilities are the debts that become payable after one year from the date of the balance sheet. They may consist of medium- and long-term loans and suppliers' credits.

Owners' equity consists of claims against the assets of the enterprise by its owners-in other words, what is left after all liabilities have been deducted from total assets. In the case of public sector enterprises, the owner is generally the government, although some public sector firms may have nongovernment shareholders. Owner's equity generally takes the form of share capital paid in by owners of the enterprise and retained earnings ("reserves" in British usage). Various other kinds of reserves may also appear under equity that do not fit precisely into the description of capital and retained earnings.

Income Statement

The income statement is a financial report that summarizes the revenues and expenses of an enterprise during the accounting period. It is thus a statement that shows the results of the operation of the enterprise during the period. Net income, or profit, is what is left after expenses incurred in production of the goods and services delivered have been deducted from the revenues earned on the sale of these goods and services. In other words, income (profit) = revenues - expenses. Thus, in the South Nyanza example in table 5-2, the net income is the sales revenue less all expenses.

Revenue in most processing enterprises will come from sales of goods and services in the South Nyanza example, sugar and molasses. Sales are shown net of sales discounts, returned goods, and sales taxes.

The cash operating expenses list all the cash expenditures incurred to produce the output. Important among these are expenditures for labor (which in the South Nyanza example is included in factory variable cost) and for raw materials, in this case largely sugarcane purchased from outgrowers. Subtracting these direct costs incurred in the production of the goods sold from the revenue gives the gross income (or gross profit).

Selling, general, and administrative expenses are shown next. These include a number of overhead items-in the South Nyanza example, general administration, training, research, and the management fee to be paid the firm that will operate the sugar mill. Maintenance costs are often included as a separate entry in this category.

We now reach the funds from operations, also called the operating income before depreciation. This is the net benefit or cash flow of the enterprise that arises from operations. If the account is built on an incremental basis, it is the incremental net benefit from operations. (It is not the incremental net benefit or cash flow for the enterprise as a whole during each year over the life of the project, since we must deduct the investment costs that come from the sources-and-uses-of-funds statement discussed in the next section. This expense is shown as depreciation in the income statement. See the last section of this chapter, on financial rate of return.) Funds from operations are sometimes also called the internally generated funds. Funds from operations becomes the first element in the sources-and-uses-of-funds statement and is also the basis for transferring the net benefits of the enterprise to the summary project accounts from which the estimated economic return of the project is derived. Before this is done, however, any element in the revenues, cash operating expenses, and selling, general, and administrative expenses that is a direct transfer payment or that has an economic value different from its market price must be omitted or revalued along the lines given in chapter 7.

Next we list the noncash operating expenses, of which the primary element is depreciation. In accounting, depreciation refers to the process of allocating a portion of the original cost of a fixed asset to each accounting period so that the value is gradually used up, or written off, during the course of the useful life of the asset. Allowance may be made for the resale value of the fixed asset-its residual value at the end of its useful life to the enterprise. The most common depreciation method is "straight-line depreciation," which allocates an equal portion of the value of the fixed asset to each accounting period; in contrast, various methods of accelerated depreciation allocate more of the depreciation to earlier accounting periods than to later. The principal other noncash operating expense is amortization, the gradual writing off of intangible assets such as royalties or patents.

Deducting the noncash operating expenses gives us operating income (or operating profit), also called the profit before interest and taxes. Nonoperating income and expense are subtracted next. When an enterprise will receive interest payments, as is the case of the South Nyanza example, it is convenient to include interest received at this point, so that all interest transactions will appear at one point in the income statement. Interest received is thus shown as a "negative expense." In most enterprises, interest paid is among the most important nonoperating income and expense items. Duties and indirect taxes are also included among the nonoperating income and expenses unless they have been allowed for elsewhere. Duties, for instance, may appropriately be included among the expenses. In the South Nyanza example, duties on imported machinery were included in the purchase price of the machinery and thus were not shown separately under this entry. Indirect taxes also may not appear separately in income statements. In the South Nyanza example, we noted earlier that sales taxes were deducted before entering the sale revenues in accord with normal practice. In effect, the enterprise is simply acting on behalf of the government when it collects a sales tax, and the amount of the tax does not enter the income statement. In the South Nyanza example, the excise tax on molasses also was not shown separately but is properly included as part of the expenses. Among the indirect taxes that might be shown are franchise taxes and a value added tax-a tax levied as a proportion of the increased value generated at each stage in the processing and handling of a product up to the final sale. Finally appear subsidies. Again, subsidies may not appear at this point in the income statement. They may be incorporated elsewhere (for example, in the price that an enterprise pays for a subsidized input), or they may be shown as a revenue (as in the case of export incentive payments).

Thus we reach income (profit) before income taxes. Now, deducting the income taxes, we obtain the final entry, the net income (profit) after taxes. This is the return to the owners of the enterprise and is available either for distribution to them or for reinvestment in the enterprise.

Financial accounts must be linked to all other accounts. As the accountants put it, accounts must be "articulated." We noted that the funds from operations in the income statement becomes the first element in the sources-and-uses-of-funds statement. The income statement is also a bridge between successive balance sheets. The net income, after payment of dividends to shareholders, is transferred to the balance sheet as retained earnings and thereby increases the owners' equity. To trace this transaction, a reconciliation statement, such as a retained earnings statement, would be required to show any distribution of earnings as dividends before the retained earnings are added to the owners' equity in the balance sheet. In the South Nyanza example, it was assumed that all earnings would be retained by the enterprise throughout the sixteen years for which the projected accounts were prepared. Looking at years 9 and 10 reproduced in tables 5-1 and 5-2, we can see the articulation between the balance sheet and the income statement. The net income in year 10 given in the income statement in table 5-2 is KSh53,890 thousand. Adding this amount to the retained earnings at the end of year 9, shown in the projected balance sheets in table 5-1 to be -KSh43,355 thousand, gives a retained earnings in year 10 of KSh10,535 thousand (-43,355 + 53,890 = 10,535). Table 5-3 shows projected retained earn-ings statements for the South Nyanza example. Reconciliation accounts are uncommon for government-owned operating entities that retain all earnings in the enterprise.

Sources-and-Uses-of-Funds Statement

The sources-and-uses-of-funds statement highlights the movements of investment funds over the life of the project. It is a vehicle for measuring the total flow of financial resources into and out of an enterprise during an accounting period and for projecting this total flow into the future. The sources-and-uses-of-funds statement is also called the sources-and-applications-of-funds statement, the funds statement, the statement of change in working capital, or sometimes simply the cash flow, since the flow of funds is reflected in the final analysis by changes in the cash position of an enterprise. This accounting definition of cash flow, however, differs from that used in project analysis to measure the return on the resources engaged in the project.

The most common sources of funds are outlined in the first part of table 5-4. The first of these is funds from operations (or the operating income before depreciation). When the accounts are laid out following the pattern given here, this can be taken directly from the income statement as illustrated in the South Nyanza example. Often, however, the funds from operations does not show as a separate item in a set of accounts and will have to be constructed by adding depreciation and other noncash charges back to the operating income.

To the funds from operations are added the increase in equity, the long-term loans received, and the increase (decrease) in short-term loans. In the South Nyanza example, equity and loans come from a wide variety of sources. The government of Kenya contributes part of the equity financing that, in turn, it is to obtain from the proceeds of a World Bank loan, and part of the equity comes from a private firm. Long-term loans come from a variety of international financing institutions and from suppliers' credits. The capital structure of the firm is such that it does not need short-term loans in the years we have chosen as illustrative examples,

Table 5-3. Retained Earnings Statements, South Nyanza Sugar Company

Item	Project year			
	1	9	10	11
Net income	(9,728)	52,714	53,890	42,486
Dividends	-	-	-	-
Increase in retained earnings	(9,728)	52,714	53,890	42,486
Accumulated retained earnings	(9,728)	(43,355)	10,535	53,021

Source: Same as table 5-2.

but in many agricultural processing enterprises short-term loans would be needed to enable the enterprise to carry inventories of raw materials purchased at harvest time and stocks of processed goods that will be sold during the year.

Interest received is the next source of funds; in the South Nyanza example, it comes from short-term loans made to outgrowers. The increase (decrease) in accounts payable and other short-term liabilities (except current portion of long-term loans received) follows. An enterprise might obtain part of its funds by increasing the amounts purchased on terms from its suppliers or by postponing payment to its suppliers. If it reduces the amount purchased on terms or the average time it takes to pay its suppliers from one year to the next, this would cause a decrease in accounts payable and a reduction of the funds available. Because we are looking, in general, at an expanding firm that will be increasing its accounts payable in the normal course of widening the scope of operations under the project, an increase in accounts payable will usually be found in the sources-and-uses-of-funds statement. When a decrease occurs, however, it is convenient to enter it as a "negative source" in the accounts rather than as an additional line among the uses of funds. In some agricultural projects, the processing enterprise may be expected to operate at a loss to increase the income of farmers. If so, the firm may expect direct subsidies to be one source of its funds.

Among the major uses of funds (second part of table 5-4) in the projected sources-and-uses-of-funds statements for a project with an expanding processing enterprise will likely be the increase (decrease) in gross fixed assets. This item shows the investment in fixed assets during each year; in the South Nyanza example, this is principally investment in new milling capacity. In other cases an enterprise may decrease fixed assets by selling them. If this transaction exceeds the purchase of fixed assets, the net result would most easily be shown as a "negative use" among the uses of funds rather than as a separate entry for the proceeds from the sales of fixed assets among the sources of funds.

A major item in the projected sources-and-uses-of-funds statements for an enterprise included in an agricultural project will most likely be repayment of long-term loans. (Recall that among the sources of funds shown is the increase or decrease in short-term loans. Since this is shown on a net basis, there is no need for a separate entry among the uses of funds for repayment of short-term loans.) Only the principal repayment is included under the repayment of long-term loans. Interest payments on long-term loans and interest payments on short-term loans are segregated and shown separately. (In the South Nyanza example, the analyst assumed that the repayment of the short-term loans, shown as a decrease in short-term loans among the sources of funds, would be made at the very beginning of the accounting period; hence, there is no short-term interest shown in the account for year 9.) An enterprise that has borrowed for expansion, such as the South Nyanza Sugar Company, may have to pay loan commitment fees for undisbursed amounts of loans that have been made to it.

The increase (decrease) in inventories shows the change in the inventory position of the enterprise. Because most projected accounts are for expanding enterprises, it is likely that this entry will reflect an increase in inventories; the entry is therefore included among the uses of funds. Sometimes, however, there may be a decrease in inventories. Rather than have an additional line under sources of funds, it is convenient to treat a reduction in inventory as a negative use. In the South Nyanza example, the major inventory is the standing cane crop on the nucleus

Table 5-4. Sources and Uses of Funds, South Nyanza Sugar Company

Item	**Project year**			
	1	**9**	**10**	**11**
Sources				
Funds from operations (operating income before depreciation)	(2,281)	108,007	117,078	131,041
Increase in equity				
Government	54,150	-	-	-
Mehta Group	2,850	-	-	-
Total increase in equity	57,000	-	-	-
Long-term loans received				
World Bank	-	-	-	-
Suppliers' credit	32,700	-	-	-
European Investment Bank	33,400	-	-	-
Exim Bank	7,900	-	-	-
East African Development Bank	6,070	-	-	-
Total long-term loans received	80,070	-	-	-
Increase (decrease) in short-term loans	-	(19,000)	-	-
Total increase (decrease)in short-term loans	-	(19,000)	-	-

Table 5-4. Sources and Uses of Funds, South Nyanza Sugar Company

Item	Project year			
	1	9	10	11
Interest received	-	4,245	4,770	5,048
Increase (decrease) in accounts payable and other short-term liabilities (except current portion of long-term loans received)	-	-	-	-
Subsidies	-	-	-	-
Total sources	134,789	93,252	121,848	136,089
Uses				
Increase (decrease) in gross fixedassets'	118,986	22,445	10,628	18,064
Repayment of long-term loans				
World Bank	-	6,563	6,563	6,563
Suppliers' credit	-	13,431	13,431	13,381
European Investment Bank	-	10,956	10,956	10,956
Exim Bank	-	-	-	-
East African Development Bank	-	2,846	2,846	2,846
Total repayment of long-term loans	-	33,796	33,796	33,746
Interest payments on long-term loans				
World Bank	-	11,370	10,681	9,992
Suppliers' credit	-	3,482	2,411	1,607
European Investment Bank	2,004	3,946	3,289	2,632
Exim Bank	711	-	-	-
East African Development Bank	668	940	627	314
Interest payments on short-term loans	-	-	-	-
Total interest payments	3,383	19,738	17,008	14,545
Loan commitment fees				
World Bank	984	-	-	-
Exim Bank	69	-	-	-
East African Development Bank	139	-	-	-
Total loan commitment fees	1,192	-	-	-

Table 5-4. Sources and Uses of Funds, South Nyanza Sugar Company

Item	Project year			
	1	9	10	11
Total debt service	4,575	53,534	50,804	48,291
Increase (decrease) in inventories				
Standing cane crop	3,428	(827)	(1,365)	(2,007)
Other inventories b	1,525	-	-	-
Total change in inventories	4,953	(827)	(1,365)	(2,007)
Increase (decrease) in accounts				
receivable	2,952	2,295	845	424
Increase (decrease) in other short-term assets except cash				-
Income taxes paid	-	-	8,618	34,761
Dividends paid	-	-	-	-
Adjustments for items not				
covered above	-	-	-	-
Total uses	131,466	77,447	69,530	99,533
Net funds flow				
Current surplus (deficit)	3,323	15,805	52,318	36,556
Opening cash balance	-	1,436	17,241	69,559
Cumulative surplus (deficit)	3,323	17,241	69,559	106,115

Source: Same as table 5-1 (annex 20, table 13).

a. Includes investment in the factory, agriculture, administration, housing, and company-related research.

b. Includes spare parts, tools, and operating materials.

plantation. As indicated in table 5-4, this inventory does decrease during years 9 through 11-thus it is shown as a negative entry in the account. The increase (decrease) in accounts receivable appears next. If a firm is expanding, it will likely be extending credit to an increasing number of customers, and its accounts receivable will expand. But if it is able to reduce the average length between delivery and payment or be more restrictive in extending credit, its accounts receivable may decrease during the year and be shown as a negative use. The increase (decrease) in other short-term assets except cash would allow for changes in holdings of such short-term assets as notes, certificates of deposit, or treasury bills.

Income taxes paid are an obvious use of funds for an enterprise, and there may be dividends paid by the enterprise to its equity owners.

Finally, an entry for adjustments for items not covered above comprises those items that for various reasons do not fit well into one of the pattern categories. Any items of substance in this entry should be fully disclosed in footnotes to the accounts.

What remains is the net funds flow, of which the first element is the current surplus (deficit). Adding the opening cash balance to the surplus or deficit gives the cumulative surplus (deficit). If the projected accounts indicate a cumulative cash deficit-a deficiency of funds-then some arrangements will have to be made to sustain the enterprise during this period. It may be necessary to reduce planned dividends, arrange for additional loans or equity, or in some other way plan to provide the necessary funds.

Projecting the sources-and-uses-of-funds statements enables the analyst to be certain that the available financing for the enterprise will be sufficient to cover the investment program-including increases in inventories, other permanent working capital, and all cash expenditures for operations-and to cover obligations of interest and the principal repayment on all outstanding loans. Projecting the sources-and-uses-of-funds statements year by year makes it possible to check the timing of inflows from various sources to be certain that these inflows will be available as the need arises. Credit agencies can assess the total flow of funds from operations before debt service to determine how adequately the debt service is covered. Owners will be looking at the projected flow of funds after debt service to judge what their returns will be. For private investors, the funds generated after debt service and the projected dividends will be important elements in their decisions about whether to participate in the project.

Financial Ratios

From the projected financial statements for an enterprise, the financial analyst is able to calculate financial ratios that allow him to form a judgment about the efficiency of the enterprise, its return on key aggregates, and its creditworthiness. We will discuss several of the most significant of these ratios, but there are many others that financial analysts use and that are particularly appropriate for specific kinds of enterprises. For each ratio we will discuss, the means of computation is summarized in table 5-5. Two examples of the application of the ratios are given in the table, based on years 10 and 11 of the South Nyanza Sugar Company accounts reproduced in tables 5-1, 5-2, and 5-4.

In general, it is not possible to give ranges within which financial ratios should fall. Instead, the analyst will have to form a judgment about whether the ratio indicates an acceptable situation for the kind of enterprise that is the subject of the projected accounts. For more information about the use of financial ratios, the project analyst may consult a standard accounting text or Upper (1979), from which this discussion draws heavily.

The ratios given here have all been computed using the figures at the end of each year. This weights the analysis toward the last months of operations; as long as clarity and consistency are maintained, this usually poses no problem. If the activities of an enterprise are highly seasonal, as is often the case in agricultural projects, calculating the ratios on a year-end basis could easily be misleading. In that instance, the analyst may want to examine the pattern of seasonal fluctuations within the accounting period and make a judgment about whether the seasonal variation would affect his conclusions about the efficiency, return, or creditworthiness of the proposed enterprise.

Efficiency ratios

The first group of ratios (first part of table 5-5) enables the analyst to form a judgment about the efficiency of the proposed enterprise. They provide measurements of asset use and expense control.

Inventory turnover measures the number of times that an enterprise turns over its stock each year and indicates the amount of inventory required to support a given level of sales. The ratio can be computed in several ways. In the form given here, the cost of goods sold is divided by the inventory. In the South Nyanza example in table 5-5, for year 10 this amounts to 3.94 times a year. In agricultural processing industries, this ratio may be low compared with that of many manufacturing enterprises; this lower ratio reflects the highly seasonal nature of agricultural processing. The inventory turnover can also relate to the average length of time a firm keeps its inventory on hand. In the South Nyanza example, the firm has about ninety-three days of inventory on hand at the end of year 10. We determine this by dividing the days in the year by the inventory turnover ratio (365 _ 3.94 = 93). We could also state this in months-the firm has about three months of inventory on hand-by dividing the months of the year by the inventory turnover ratio (123.94 = 3). A low turnover ratio may mean that a company with large stocks on hand may find it difficult to sell its product, and this may be an indicator that the management is not able to control its inventory effectively. A low turnover ratio may, however, also mean that large stocks must be held to ensure that production schedules are met. A low ratio means a sizeable amount of funds are tied up. A high turnover ratio may mean that the enterprise is able to recover its inventory investment rapidly and that there is a good demand for its products. On the one hand, when the ratio is much higher than the industry average, it may mean that the enterprise is very efficient in managing its inventories. On the other hand, it may mean that the enterprise is starved of funds and cannot afford to maintain a sufficient inventory; as a result, it may be forced to forgo sales opportunities.

The operating ratio is obtained by dividing the operating expenses by

Table 5-5. Financial Ratios, Sout Nyanza Sugar Company

Ratio	Project Year	
	10	11
Inventory turnover =Cost of goods sold/Inventory	122,981 /(24.181 + 7.000) = 3.94	130,347 /(22,174 + 7,000)= 4.47
Operating ratio (percent) = Operating expenses/Revenue	179,485/254,231 x 100 = 71	189,477/276221 x 100 = 69
Return on sales (percent) =Net Income/Revenue	53,890/254,231 x 100 = 21	42,486/276,221 x 100 = 15
Return on equity (percent)= Net Income/ Equity	53,890/207,035 x 100 = 26	42,486/276,221 x 100 = 17
Return on assets (percent)= Operating income/ Assets	74,746/379,321 x 100 = 20	86,744/388,061 x 100 = 22
Current ratio =Current Assets/Current Liabilities	148,787/33,746 = 4.41	183,879/20363 = 9.03

Table 5-5. Financial Ratios, Sout Nyanza Sugar Company

Ratio	Project Year	
	10	11
Debt-equity ratio =Long-term liabilities/(Long-term liabilities + equity)	138,540 /(138,540+207,035) = 0.40	118,177(118,177 + 249,521)=0.32
Equity /(Long-term liabilities + equity)	207,035 /(138,540 + 207,035)=.60	249,521/(118,177 + 249,521)=.68
Therefore, Debt-equity ratio =	40:60	32:68
Debt service coverage ratio =		
(Net income + depreciation+interest paid)/Interest paid+repayment of long-term loans	(53,890 + 24,172+18,160+17,008)/ 17,008+33,796 = 2.23	(42,486 + 24,172+20,125+14,545)/14,545 + 33,746 = 2.10

the revenue. In the South Nyanza example, for year 10 the operating ratio is 71 percent. The operating ratio is an indicator of the ability of the management to control operating costs, including administrative expenses. This ratio is most useful when operations of the same enterprise are compared year by year or when the enterprise is compared with similar industries. If the ratio is increasing, it may mean that the cost of raw materials is increasing, that the management is having problems controlling labor costs, that there is waste in the production process, or, when sales decline, that expenses have not been trimmed proportionately. It may also mean that there is substantial competition and that it is necessary to reduce prices. If there is uncertainty about whether the increase in the ratio is due to increasing costs or decreasing sales prices, the answer can usually be found by taking the operating expenses and dividing that by the company sales volume on a unit basis (for instance, the number of tons of refined sugar sold in the South Nyanza example). In general, the larger the capital investment is relative to sales volume, the lower will be the operating ratio. If a company has made a large investment, it must be able to recover it with a high cash flow, which can only be accomplished generally through a low operating ratio. If an enterprise has a high operating ratio, say in the neighborhood of 90 percent, it may have difficulty making an adequate return. If it is abnormally low, say 50 percent, then some costs have likely been omitted or underestimated.

Income ratios

The long-term financial viability of an enterprise depends on the funds it can generate for reinvestment and growth and on its ability to provide a satisfactory return on investment. We will look at three ratios (second part of table 5-5) that can be used to judge net income or profitability-return on sales, return on equity, and return on assets. Because of their importance in project analysis and because they are somewhat more difficult to calculate, we will defer to the next section consideration of three other income measures-the rate of return on all resources engaged, the rate of return on equity before income taxes, and the rate of return on equity after taxes.

Income ratios are calculated on a year-to-year basis and may be noted in the projected statements for an enterprise. That will provide some idea of the changing income ratios over the life of the project. If a company is granted a tax holiday for the first years of its operations, it is necessary to forecast its accounts through the end of the tax holiday period to determine the full effect of taxes on the company.

The return on sales shows how large an operating margin the enterprise has on its sales. This is determined by dividing the net income by the revenue. In the South Nyanza example, the return on sales in year 10 is 21 percent. The lower the return on sales-hence, the operating margin-the greater the sales that must be made to make an adequate return on investment. The ratio is most useful when comparing companies in the same sector or industry or when analyzing the results of past operations and comparing projections for future expansions. Comparisons among industries may have little meaning because of the widely varying structure of different industries.

One of the most important ratios is the return on equity. It is obtained by dividing the net income after taxes by the equity. In the South Nyanza example, for year 10 this is 26 percent. This ratio is frequently used because it is one of the main criteria by which owners are guided in their investment decisions. It can also be used to weigh incentives for individual owners if the enterprise is to be in the private sector.

The earning power of the assets of an enterprise is vital to its success. A principal means of judging this is to determine the return on assets, which is the operating income divided by the assets. In the South Nyanza example for year 10, this is 20 percent. The return on assets is the financial ratio that comes closest to the rate of return on all resources engaged (for more detail, see the next section). A crude rule of thumb is that, once the enterprise is operating at normal capacity, the return on assets should exceed the cost of capital in the society as measured by, say, the bank lending rate to industries-provided that there is no interest subsidy. Public sector enterprises usually should also be able to realize a return of this order, since if they do not, it is evidence that public funds would be better employed in other enterprises.

Creditworthiness ratios

The purpose of creditworthiness ratios (final part of table 5-5) is to enable a judgment about the degree of financial risk inherent in the enterprise before undertaking a project. They are also a basis for the project analyst to estimate what financing an enterprise will need and what will be suitable terms. Some firms, especially those in the private sector, attempt to finance their projects with as much debt as possible so they may realize maximum return on their own equity contribution. This can be risky, especially in an unstable industry or in an economy subject to substantial business cycles. An enterprise should be financed in such a way that it is able to survive adverse circumstances without emergency measures.

The current ratio is the current assets divided by the current liabilities. In the South Nyanza example, for year 10 the ratio is 4.41. From the standpoint of the credit agency, the current ratio is an indication of the margin that the enterprise has for its current assets to shrink in value before it faces difficulty in meeting its current obligations. In the South Nyanza example, in year 10-even if the current assets are worth only one-fourth the value given in the accounts-the sugar mill could still pay its creditors from these assets.

A rule of thumb sometimes applied to the current ratio is that it should be around 2. As with all rules of thumb, this figure should be used with caution. If the company has a rapid inventory turnover and can easily collect its receivables, the current ratio can be lower. If the ratio drops to near 1, then the enterprise will be in a potentially unstable position. If the ratio is low, it may mean that the enterprise is undercapitalized, and consideration will have to be given to providing more capital, either through increased equity or more long-term debt. Faced with a low current ratio, an enterprise will have to exist on a day-to-day basis, and thus it may have to adopt uneconomic practices. Its products may have to be sold at lower prices to receive payment in cash, or it may lose sales to competitors that can offer better credit terms. It may not be able to carry sufficient inventories to meet its sales needs. Inventories of raw material may be so low that its production efficiency is impaired. It may have to buy from importers in high-cost, small lots instead of buying large, low-priced shipments of inputs direct from overseas suppliers, and it may be forced to buy on credit instead of being able to take advantage of cash discounts. With a low current ratio, an enterprise may be forced to defer preventive maintenance, and this drives up costs later.

An important financial ratio for credit agencies is the debt-equity ratio. The amount of equity in an enterprise can be described as a "cushion" by which a company can absorb initial losses or weather bad times. Because debt carries a fixed rate of interest and fixed repayment of principal, too much debt may saddle a company with obligations it cannot meet when conditions are unfavorable. (A better measure of the cushion is the debt service coverage ratio, discussed below.)

The debt-equity ratio is calculated by dividing long-term liabilities by the sum of long-term liabilities plus equity to obtain the proportion that long-term liabilities are to total debt and equity, and then by dividing equity by the sum of the long-term liabilities plus equity to obtain the proportion that equity is of the total debt and equity. These are then compared in the form of a ratio. In the case of the South Nyanza example, for year 10 the long-term liabilities divided by the sum of the long-term liabilities plus the equity is 0.40. The equity divided by the sum of the long-term liabilities plus equity is 0.60. The debt-equity ratio, therefore, is 40 to 60. This may be interpreted as saying that, of the total capitalization in the enterprise, 40 percent is debt and 60 percent is equity. There is no good rule of thumb for the debt-equity ratio. In newly established enterprises, equity ideally should exceed the debt, but in many developing countries equity capital may be scarce, and such a conservative rule may not be sensible given the national objectives. If the enterprise is in the public sector, with a high proportion of the debt held by public sector agencies, the debt-equity ratio may lose some of its importance because of the presumption that, if the company falls on hard times, it will be possible to renegotiate some portion of the debt held by public agencies. In agricultural projects, enterprises are likely to need a strong equity base because they process or sell commodities that may sharply fluctuate in price and that are subject to adverse weather conditions or a fall in crop or livestock production.

The most comprehensive ratio of creditworthiness is the debt service coverage ratio. This is the net income plus depreciation plus interest paid divided by interest paid plus repayment of long-term loans. In the case of the South Nyanza example, for year 10 the debt service coverage ratio is 2.23.

The debt service coverage ratio could also be calculated on a before-tax basis, in which case it is simply the funds from operations divided by the interest plus repayment of long-term loans. In the case of the South Nyanza example, for year 10 (not shown in table 5-5) this would be 2.30 [117,078 _ (17,008 + 33,796) = 2.30]. Financial analysts who use the after-tax basis argue that taxation is a routine and unavoidable aspect of doing business. But analysts who prefer the before-tax basis argue that debt service coverage should be seen as the ability of funds from operations to satisfy debt obligations before such tax shields as depreciation and other noncash charges are applied to reduce taxable profits. The viewpoint of the analyst will be affected by whether the company is in the public or private sector.

Again, it is hard to give a rule of thumb for the debt service coverage ratio. One way of looking at it is that, in the case of the South Nyanza Sugar Company in year 10, the net income plus depreciation plus interest paid could drop by half and the enterprise could still meet its debt obligations. The analyst would have to look at each of the elements making up the ratio and form a judgment about how likely it is that any element could vary from the projected amount. A declining trend in the debt service coverage ratio in a projected account might indicate overly ambitious expansion. A persistently low debt service coverage ratio might indicate that consideration should be given to changing the credit terms to lengthen the repayment period.

The debt service coverage ratio interpreted alone can be misleading. There are many requirements that a successful enterprise must satisfy in addition to simply covering its debt service obligations. A full analysis of the sources and uses of funds for the enterprise is needed. The true buffer for debt service is only the pool of funds remaining after meeting all requirements for maintenance and improvement of current operations and orderly expansion.

Financial Rate of Return

A useful financial measure that is very important in project analysis is the financial rate of return. We will discuss three variations that differ only in the standpoint from which the calculations are made-the financial rate of return to all resources engaged, the financial rate of return to equity, and the financial rate of return to equity after taxes.

Calculations of rates of return are based on an incremental net benefit flow. This is the "cash flow" that is meant by references to discounted cash flow measures of project worth such as the net present worth, the internal rate of return, or the net benefit-investment ratio (all are discussed in detail in chapters 9 and 10). In this section we will discuss only derivation of the incremental net benefit; the discussion of discounting and of the measures based on incremental net benefit flows will be found in chapter 9.

In rate of return calculations we want to determine the actual cash inflows and outflows of the project each year and incorporate them in the incremental net benefit. Noncash receipts and expenditures are omitted (except for items in kind such as those we discussed in chapter 4 in connection with the farm budgets). Thus, the year an investment is made it reduces the net benefit for that year; when a revenue is realized, it too is reflected in the same year it is received. Because we are preparing the projected accounts over the life of the project, it is unnecessary to include depreciation (which is the major noncash expenditure in most accounts) to allow on an annual basis for the capital value consumed during the year.

From the projected income statements and sources-and-uses-of-funds statements for an enterprise as we have laid them out, we can determine the incremental net benefit streams we need to calculate the financial rate of return. The general format is given in table 5-6 and is illustrated by the South Nyanza Sugar Project accounts examined in tables 5-2 and 5-4. All the relevant entries are included in table 5-6 for illustrative purposes, even if the South Nyanza example did not use a particular entry. The entries appear in the order they are found when consulting

Table 5-6. Derivation of Incremental Net Benefit, South Nyanza Sugar Company

Item	Without Project	Project year			
		1	9	10	11
Inflow					
Revenue -	-	-	236,572	254,231	276,221
Subsidies -	-				
Total inflow -	-	-	236,572 -	254,231	276,221
Outflow					
Cash operating expenses -	-		114,728	122,981	130,347

Table 5-6. Derivation of Incremental Net Benefit, South Nyanza Sugar Company

Item	Without Project	Project year			
		1	9	10	11
Selling, general, and administrative expenses	-	2,281	13,837	14,172	14,833
[Funds from operations]	-	[(2,281)	108,007	117,078	131,041]
Duties and indirect taxes -	-	-	-	-	-
Increase (decrease) in gross fixed assets	-	118,986	22,445	10,628	18,064
Increase (decrease) in inventories	-	4,953	(827)	(1,365)	(2,007)
Total outflow	-	126,220	150,183	146,416	161,237
Net benefit before financing					
Total	-	(126,220)	86,389	107,815	114,984
Incremental	-	(126,220)	86,389	107,815	114,984
Financing					
Long-term loans received	-	80,070	-	-	-
Increase (decrease) in short-					
term loans	-	-	(19,000)	-	-
Interest received	-	-	4,245	4,770	5,048
Increase (decrease) in accounts payable and other short-term liabilities	-	-	-	-	-
Repayment of long-term loans	-	-	(33,796)	(33,796)	(33,746)
Interest payments	-	(3,383)	(19,738)	(17,008)	(14,545)
Loan commitment fees	-	(1,192)	-	-	-
Decrease (increase) in accounts receivable	-	(2,952) (	2,295) (	845) (	424)
Decrease (increase) in other hort-term assets except cash	-	-	-	-	-
Net financing	-	72,543 (	70,584) (	46,879) (	43,667)
Net benefit after financing					

Table 5-6. Derivation of Incremental Net Benefit, South Nyanza Sugar Company

Item	Without Project	Project year			
		1	9	10	11
Total	-	(53,677)	15,805	60,936	71,317
Incremental	-	(53,677)	15,805	60,936	71,317
Income taxation					
Income taxes paid	-	-	-	8,618	34,761
Net benefit after financing and taxes					
Total	-	(53,677)	15,805	52,318	36,556
Incremental	-	(53,677)	15,805	52,318	36,556
Financial rate of return to all resources engaged = 14 percent. Financial rate of return to equity before income taxes = 16 percent. Financial rate of return to equity after taxes = 13 percent`					

Source: Tables 5-2 and 5-4.

a. Calculated from the incremental net benefit before financing. For details about methodology of the computation, see chapter 9.

b. Calculated from the incremental net benefit after financing.

c. Calculated from the incremental net benefit after financing and taxes.

the first the income statements and then the sources-and-uses-of-funds state-ments. Only the rate of return is usually reported. Were the table itself to be used in a project report, it might be desirable to group the entries so that related items are not separated.

The first financial rate of return to be determined is the financial rate o f return to all resources engaged, which is a measurement of the financial viability of an enterprise. It is based on the incremental net benefit before financing. In the South Nyanza example, the rate of return to all resources engaged, assuming a thirty-year life for the project, is 14 percent. When all the elements that enter into the derivation of the incremental net benefit before financing are revalued to reflect economic values (as discussed in chapter 7) and any transfer payments are taken out, the incremental net benefit before financing becomes the basis for aggregating the net economic benefit from the enterprise and carrying it into the economic accounts for the project.

To obtain the incremental net benefit before financing, we begin with the revenue and direct subsidies received; these are taken from the income statements, which total to give the total inflow. The first two entries among the outflows are the cash operating expenses and the selling, general, and administrative expenses, also taken from the income statements. (At this point, if there were no direct subsidies, we would have the funds from operations; an alternative calculation of financial rates of return would there-fore be to begin with the funds from operations, add any direct subsidies, and deduct any of the other elements of the outflow that are relevant.) Continuing with the outflow entries, we add duties and indi-rect taxes as shown in the income statements and add or subtract, as appropriate, the increase (decrease) in gross fixed assets and the increase (decrease) in inventories as shown in the sources-and-uses-of-funds statements. The result is the total outflow. Subtracting the total outflow from the total inflow provides the total net benefit before financing. Subtracting what would be the net benefit without the project (which, in the South Nyanza example, is nothing), we now reach the incremental net benefit before financing.

The financial rate of return to equity before income taxes will be an important consideration to any potential private investors. It is also of concern if the enterprise is to be a financially responsible public sector enterprise that must demonstrate the good use it makes of resources put at its disposal. The return to equity before income taxes will help the project analyst judge the attractiveness of the proposed enterprise to potential investors and to determine if the financing plan will give rise to undue windfall profits. It may also help in deciding what special tax holiday or other exemption may be justified. For the South Nyanza example, the return on equity before income taxes is 16 percent. To determine the return to equity before income taxes, we need to calculate the incremental net benefit after financing, and to reach this we add or subtract the financing elements shown in the sources-and-uses-of-funds statements, indicating the sign in the account as we proceed. Note the inclusion of accounts payable and accounts receivable as part of the financing. Because a decrease in accounts receivable increases the funds available to the enterprise, it is decreases that are added to obtain the net financing. The heading on these entries has been reversed from that in the sources-and-uses-of-funds statements to indicate that decreases are to be added and increases subtracted. Finding the algebraic total gives the net financing, and subtracting that from the net benefit before financing gives the total net benefit after financing. Subtracting the without-project net benefit after financing (in this case, nothing), we reach the incremental net benefit after financing.

Finally, we determine the financial rate of return to equity after taxes, which is based on the incremental net benefit after financing and taxes. For the South Nyanza example, it is 13 percent. To determine the incremental net benefit after financing and taxes, we deduct income taxes from the net benefit after financing and subtract the without-project amount (in this case, nothing). This is the flow that will accrue to the equity owners after the enterprise has met its tax obligation. It is, of course, this flow that is of most concern to potential investors, and so the rate of return to equity after taxes is an important measure on which to base judgments about the incentives to invest in an enterprise.

6. ANALYZING PROJECT EFFECTS ON GOVERNMENT RECEIPTS AND EXPENDITURES

Implementing an agricultural project has obvious implications for government receipts and expenditures. The amount and timing of additional government receipts generated by a project and the effect of the project on government expenditures should be traced by the analyst. This will permit the government to plan for the capital investment in the project and to ensure that sufficient government funds will be available to meet the recurrent cost of the project. By tracing the foreign exchange flow generated by the project, the analyst can estimate the effect of the project on the balance of payments. The proportion of the cost and the proportion of the new benefit to be recovered by the government from the project beneficiaries should be estimated. It may be desirable, too, to determine how the cost of the project could equitably be allocated among the various groups that will benefit from it.

The primary issue analysis of government receipts and expenditures addresses is whether the project will generate sufficient funds to reimburse the government for the resources expended on the project. The analysis should treat the government as a distinct financial entity and should focus on inflows and outflows to and from governmental budgetary and extrabudgetary accounts to anticipate the amount and timing of project needs from government sources. Such an analysis permits careful consideration of the implications a project has for government finance to meet not only the initial investment needs of the project but also its recurrent cost. Too often inadequate attention is paid to recurrent cost, and then budgetary stringencies starve a project for funds-greatly reducing its efficiency, leading to a waste of resources, and dashing the expectations of farmers and others who participate.

It is common in agricultural projects that user charges or benefit taxes assessed on the project beneficiaries are insufficient both to recover the capital investment in the project and to pay all the operation and maintenance costs of the project. This might be the case in an irrigation project, for example, in which water charges are less than the amount the government incurs for capital repayment and operating the system or in which a program to increase production makes no charge for the services of agricultural extension agents. Sometimes other revenues arising from the project will be sufficient to reimburse the government for its costs. Such might be the case if the project increased agricultural production that is destined for export and is subject to an export tax. In many instances, however, not enough of the benefit from the project will be captured through charges or by the workings of the fiscal system to reimburse the government fully. In these instances, the difference will have to come from taxes levied elsewhere in the economy or through inflation. Whether this is to be the practice or not is a policy decision; one consideration may be that poor farmers are entitled to some income transfer through an agricultural project. The point of the analysis is not to say that the project beneficiaries must pay enough to cover all the costs of the project, both capital and recurrent. It is to say that the fiscal effects of the project need to be traced so that a conscious decision can be made about reimbursement of cost incurred by the government.

Because of problems associated with budgetary stringencies, in many projects in which not all the costs are to be recovered from charges levied on project beneficiaries, the beneficiaries may still be charged enough to pay the recurrent cost of the project. This frees the project from dependence on year-to-year budget appropriations that may be subject to sudden cuts and decrease the efficiency of project implementation.

The importance of anticipating future recurrent expenditure goes much beyond the individual project analysis, of course. Any one project-unless it is very large relative to the government budget-would not impose a serious burden for recurrent expenditure. All development investments together, however, may well lead to significant recurrent government expenditure. As a general rule of thumb, in developing countries capital expenditures tend to give rise to between 10 and 15 percent of their value in recurrent costs. Moreover, as the nature of development programs in many developing countries has tended to shift more and more toward projects that do not generate revenues sufficient to reimburse the government for recurrent cost, these expenditures have tended to grow rapidly. One result has been a persistent tendency to underestimate the burden of recurrent cost.

The elements of the flows that affect government receipts and expenditures vary from project to project, and some may not always be obvious. They can, however, conveniently be cast in the form of a government cash flow account valued at market prices. Inflows will include user charges levied on project beneficiaries, new tax revenues generated as a result of the project investment, debt service for loans made to project participants, the surplus or profit made on sales of the project or on services provided, and receipts from foreign loans made to help finance the project. Expenditures will include the initial capital expenditure on the project, including direct expenditure on such items as dams and canals; loans to project participants; equity positions taken in a processing industry; recurrent costs of the project in whatever guise they occur, whether operation and maintenance, general administration, or some other form; and debt service, including commitment fees on any foreign loans received to support the project. The analysis includes among the government expenditures related costs needed to make the project effective (such as the costs of new roads or other infrastructure facilities) because, although these may not be the responsibility of the project management, they are costs incurred for the project and would appear in the project accounts when they are aggregated as discussed in chapter 8.

Many agricultural projects will have an effect on the balance of payments, so it may be desirable to do a separate analysis of the project's foreign exchange effects in a foreign exchange flow account. Analysis of project effects on government receipts and expenditures can be illustrated by an example drawn from the South Nyanza Sugar Project, the same project used in the last chapter to illustrate the financial analysis of processing industries. As before, the general headings that might be expected to appear in most analyses of this kind will appear in italic type in the text.

Government Cash Flow

The government cash flow account for the South Nyanza Sugar Project is excerpted in table 6-1.

There is a problem about whether to make government cash flow projections in constant or current terms. For financial planning by the treasury and other government agencies, a current projection is much preferred, even though this involves projecting the inflation rate both domestically and worldwide. [A projection of worldwide inflation for capital goods is available in Price Prospects for Major Primary Commodities (World Bank 1982a).] But projecting inflation is difficult at best, and when done for more than just a few years it is of very little usefulness. In the South Nyanza project, therefore, the analyst chose a useful compromise: he projected the government cash flow in current terms for the five years of the investment phase during which the sugar factory was to be built. Then, from year 6 onward, he projected the cash flow in constant

Table 6-1.Government Cash Flow, South Nyanza Sugar Project, Kenya

Item	Project Year				
	1	2	6	7	16
	Inflow				

Table 6-1.Government Cash Flow, South Nyanza Sugar Project, Kenya

Item	Project Year				
	1	2	6	7	16
Loan receipt'					
World Bank	19,480	35,280	-	-	-
African Development Bank	3,540	13,710	-	-	-
Total loan receipt	23,020	48,990	-	-	-
Taxes					
Sugar excise [b]	-	-	63,771	79,043	127,260
Molasses excise [b]	-	-	142	176	277
SNSC income`	-	-	-	-	54,853
Other duties and taxes	15,462	27,625	15,675	13,775	17,069
Debt service receipt					
Interest payment	-	270	13,437	12,748	6,547
Loan commitment fee	984	965	-	-	-
Repayment of principal	-	-	6,563	6,563	6,563
Dividends'	-	-	-	-	63,691
Total inflow	39,466	77,850	99,588	112,305	276,260
	Outlow				
Equity in SNSC	54,150	71,250	-	-	-
Loans to SNSC[f]	-	2,570	-	-	-
Financing of Kenya Sugar Authority and training	1,828	5,555	5,563	5,726	5,451
Grant to National Sugar Research Institute	297	3,393	2,371	2,470	2,371
Road construction and maintenance'	4,430	17,294	4,996	4,996	4,996

Table 6-1.Government Cash Flow, South Nyanza Sugar Project, Kenya

Item	Project Year				
	1	2	6	7	16
Subtotal	60,705	100,062	12,930	13,192	12,818
Debt service payment					
Interest					
World Bank	1,751	4,930	49,750	48,505	37,300
African Development Bank	283	1,380	3,287	2,922	-
Loan commitment fee					
World Bank	1,411	1,145	-	-	-
African Development Bank	316	213	-	-	-
Repayment of principal					
World Bank	-	-	13,833	13,833	13,833
African Development Bank	-	-	4,565	4,565	-
Total outflow	64,466	107,730	84,365	83,017	63,951
	Net cash flow				
Current surplus (deficit)	(25,000)	(29,880)	15,223	29,288	212,309
Cumulative surplus (deficit)	(25,000)	(54,880)	(13,582)	15,706	1,313,167

KSh Kenyan shillings.
Note: In current prices for years 1 through 5 (1977-81); thereafter, in year-5 (1981) constant prices. Parentheses indicate negative numbers.

Source: Adapted from World Bank, "Kenya: Appraisal of the South Nyanza Sugar Project," 1418-KE (Washington, D.C., 1977; restricted circulation), annex 20, table 17.
a. The disbursement of the German and Indian suppliers' credit and loans from the European Investment Bank, East African Development Bank, and the U.S. Export-Import (Exim) Bank have been assumed to be directly to the South Nyanza Sugar Company (SNSC) and not through the government.

b. The excise tax per ton is in constant 1976 prices and is assumed at KSh 1,000 for sugar and KSh6 for molasses for years 1 through 5, adjusted to current terms by using a factor of 32.2 percent in year 4 (1980) and 41.4 percent in year 5 (1981) and thereafter.

c. Values are in constant 1976 prices adjusted by 41.4 percent to year-5 (1981) constant prices.

d. Includes import duties on materials, machinery, vehicles, and equipment; excise taxes on capital and current input; and income tax on staff salaries. The values are in constant 1976 prices adjusted by 41.4 percent to year-5 (1981) constant prices.

e. It is assumed that sxsc dividends to the government will be 95 percent of sxsc net profits after tax, expressed in year-5 (1981) constant prices.

f. The on-lending margin to sxsc has been assumed to be 1.5 percent.

g. Includes the incremental cost to the Kenya Sugar Authority arising from the project and the cost of training and conference participation not included in the SNSC accounts. h. Incremental cost to the National Sugar Research Institute arising from the project. i. Includes the cost of roads needed for the project not included in sxsc nucleus estate.

terms at year-5 prices. This avoided making a long-term projection of inflation. (Note that this would not be a suitable format if the cash flow were to be discounted as discussed in chapter 9.) The analyst also chose to include in his cash flow table a total column after year 5 for the first five years (not reproduced in the excerpt in table 6-1). The government cash flow is projected for sixteen years, long enough to trace the effect of all the financial transactions except the repayment of the World Bank loan.

The government cash flow account is divided into cash inflow and cash outflow. The first inflow is the loan receipt obtained from abroad to support the project. In the case of the South Nyanza project, the government of Kenya received loans from the World Bank and the African Development Bank for the project. Other loans were made by suppliers and by other international lending agencies that dealt directly with the South Nyanza Sugar Company. The flows from these loan transactions, since they did not go through the government, do not show in the government cash flow. Next in the table are the taxes. The South Nyanza project is expected to generate new tax revenues from the sugar excise tax collected at the factory gate and a similar excise tax on molasses; company income tax; and other taxes that include import duties on materials, machinery, vehicles and equipment, excise duty on capital and current inputs, and income taxes on staff salaries. Next comes the debt service receipt from the South Nyanza Sugar Company for the loan it has received from the government. The debt service is broken down into the interest payment, loan commitment fee, and repayment of principal. Finally, there is the transfer of company profit that is made to the government in lieu of dividends. Some proportion of this profit would by agreement customarily be reinvested in company expansion. Had there been any user charges, these, too, would have been included in the cash inflow.

The first entry in the cash outflow is the equity participation the government contributed to the South Nyanza Sugar Company, followed by loans to the company. These, in effect, constitute the capital cost contributed from the government budget to the company operation. Two other outflows are the financing for the Kenya Sugar Authority for training not directly administered by the company, including overseas university education in business management and sugar technology and participation in international symposia and conventions, and a grant to the National Sugar Research Institute to reimburse it for incremental expenses arising from the project. This is followed by road construction that is a part of the project cost to be paid directly by the government and not channeled through the company.

Then comes the debt service payment the government must make as a result of the project. This includes interest, loan commitment fee, and repayment of principal to the World Bank and the African Development Bank.

The difference between the cash inflow and the cash outflow gives the cash current surplus (deficit), which in the South Nyanza case is negative through project year 3 and positive thereafter. The cumulative surplus (deficit) indicates how long it will be before the government recovers its net expenditure on the project in undiscounted terms-six years in the South Nyanza example. In other projects, of course, both the current and the cumulative surplus (deficit) might remain negative throughout the life of the project.

Foreign Exchange Flow

The foreign exchange flow generated by the South Nyanza project is calculated in table 6-2.

Table 6-2. Foreign Exchange Flow, South Nyanza Sugar Project

Item	Project year				
	1	2	6	7	16
	Inflow				
Loan receipt					
Suppliers' credit-Germany	17,200	27,400	-	-	-
Suppliers' credit-India	15,500	24,750	-	-	-
World Bank	19,480	35,280	-	-	-
European Investment Bank	33,400	53,200	-	-	-
African Development Bank	3,540	13,710	-	-	-
East African Development Bank	6,070	9,670	-	-	-
Exim Bank	7,900	10,380	-	-	-
Total loan receipt	103,090	174,390	-	-	-
Foreign exchange value of sugar					
production'	-	-	248,501	308,009	495,000
Export of molasses [b]	-	-	8,261	10,235	16,114
Total inflow	103,090	174,390	256,762	318,244	511,114
	Outflow				
Foreign exchange component of:					
Agriculture	15,674	15,096	30,304	51,132	45,522
Sugar factory	68,832	107,162	51,982	14,275	19,325
General management and					
administration	2,251	2,814	5,442	5,311	5,442
Road construction and mainte-nance	3,532	13,676	3,612	3,612	3,612
Housing and social amenities	4,223	4,735	-	-	-
Research	655	2,470	1,622	2,469	1,622

Table 6-2. Foreign Exchange Flow, South Nyanza Sugar Project

Item	Project year				
	1	2	6	7	16
Training	120	294	648	648	648
Item	1	2	6	7	16
Kenya Sugar Authority	617	1,825	1,634	1,814	1,572
Management fee	-	-	2,410	3,240	6,940
Total foreign exchange component	95,904	148,072	97,654	82,501	84,683
Debt service payment					
Interest					
Suppliers' credit-Germany	-	-	3,509	2,946	-
Suppliers' credit-India	-	-	3,190	2,678	-
World Bank	1,751	4,930	49,750	48,505	37,300
European Investment Bank	2,004	5,196	5,917	5,260	-
African Development Bank	283	1,380	3,287	2,922	-
East African Development Bank	668	1,732	1,879	1,566	-
Exim Bank	771	1,645	780	388	-
Total interest payment	5,477	14,883	68,312	64,265	37,300
Loan commitment fee					
World Bank	1,411	1,145	-	-	-
African Development Bank	316	213	-	-	-
Exim Bank	69	17	-	-	-
Total commitment fee	1,796	1,375	-	-	-
Repayment of principal					
Suppliers' credit-Germany	-	-	7,050	7,050	-
Suppliers' credit-India	-	-	6,381	6,381	-
World Bank	-	-	13,833	13,833	13,833
European Investment Bank	-	-	10,956	10,956	-
African Development Bank	-	-	4,565	4,565	-
East African Development Bank	-	-	2,846	2,846	-

Table 6-2. Foreign Exchange Flow, South Nyanza Sugar Project

Item	Project year				
	1	2	6	7	16
Exim Bank	-	-	4,354	4,354	-
Total repayment of principal	-	-	49,985	49,985	13,833
Total outflow	103,177	164,330	215,951	196;751	135,816
Kenya Sugar Authority	617	1,825	1,634	1,814	1,572
Management fee	-	-	2,410	3,240	6,940
Total foreign exchange component	95,904	148,072	97,654	82,501	84,683
Debt service payment					
Interest					
Suppliers' credit-Germany	-	-	3,509	2,946	-
Suppliers' credit-India	-	-	3,190	2,678	-
World Bank	1,751	4,930	49,750	48,505	37,300
European Investment Bank	2,004	5,196	5,917	5,260	-
African Development Bank	283	1,380	3,287	2,922	-
East African Development Bank	668	1,732	1,879	1,566	-
Exim Bank	771	1,645	780	388	-
Total interest payment	5,477	14,883	68,312	64,265	37,300
Loan commitment fee					
World Bank	1,411	1,145	-	-	-
African Development Bank	316	213	-	-	-
Exim Bank	69	17	-	-	-
Total commitment fee	1,796	1,375	-	-	-
Repayment of principal					
Suppliers' credit-Germany	-	-	7,050	7,050	-
Suppliers' credit-India	-	-	6,381	6,381	-
World Bank	-	-	13,833	13,833	13,833
European Investment Bank	-	-	10,956	10,956	-
African Development Bank	-	-	4,565	4,565	-

Table 6-2. Foreign Exchange Flow, South Nyanza Sugar Project

Item	Project year				
	1	2	6	7	16
East African Development Bank	-	-	2,846	2,846	-
Exim Bank	-	-	4,354	4,354	-
Total repayment of principal	-	-	49,985	49,985	13,833
Total outflow	103,177	164,330	215,951	196;751	135,816
Net foreign exchange flow					
Current surplus (deficit)	(87)	10,060	40,811	121,493	375,298
Cumulative surplus (deficit)	(87)	9,973	258,251	379,744	3,080,980

Note: In current prices for years 1 through 5 (1977-81); thereafter in year-5 (1981) constant prices.
Source: Same as table 6-1.

a. Based on the foreign exchange element of the import substitution price of KSh3,897 per ton in constant March 1977 prices adjusted for inflation to KSh5,152 per ton in year 4 and KSh5,510 per ton from year 5 onward.

b. Based on molasses price f.o.b. Mombasa of KSh463 per ton in year 4 and KSh495 per ton from year 5 onward.

As in the case of the government cash flow, the question arises of whether to calculate the foreign exchange flow in constant or current terms. Matching his choice for the government cash flow, the analyst chose to project the foreign exchange flow in current terms for the five years of the implementation phase of the project while the sugar factory was to be built and then, from year 6 onward, in constant terms at year-5 prices. As before, this provided the treasury and other planning agencies with a current projection of the foreign exchange effects of the project for the first few years of its implementation but avoided a long-term projection of inflation. Again, the analyst chose to carry out his calculations for sixteen years, long enough to trace all the financial transactions except repayment of the World Bank loan.

The foreign exchange flow is derived by tabulating the inflow, deducting the outflow, and obtaining the net foreign exchange flow. The first inflow is the loan receipt in support of the project. Note that the suppliers' credit and loans from several international agencies were received directly by the South Nyanza Sugar Company, so they do not show in the government cash flow examined in the previous section but do appear here. Then comes the foreign exchange value of the sugar production. This is the foreign exchange saved as a result of substituting domestically produced sugar for imported sugar. The last inflow listed is the foreign exchange earned from the export of molasses.

Foreign exchange outflows include the foreign exchange component of the various aspects of project implementation, including equipment and materials purchased from abroad and management fees. The other major component of the foreign exchange outflow is the debt service payment for loans received from abroad. This includes interest, any loan commitment fee, and repayment of principal to the suppliers of equipment and the international agencies that lent to support the project.

Subtracting the total outflow from the total inflow gives the net foreign exchange flow, which is reported in two variations: the current surplus (deficit) and the cumulative surplus (deficit). In part because of the financing available, the foreign exchange effect of the South Nyanza project is positive every year except the first.

Cost Recovery

When governments invest in projects that increase the incomes of individual farmers, the question arises about how much of the government expenditure should be recovered from the project beneficiaries. Only through appropriate cost recovery policies can governments recoup the money expended on a project for investment in other projects that will benefit other members of the society. To the extent that the cost of a project is not recovered, some part of the project benefit individuals receive represents a subsidy paid by others in the society who did not benefit from the project.

There are two important issues to be addressed in formulating cost recovery policy. One is the proportion of the cost expended on a project to be repaid. The other is the proportion of the benefit received by individuals (which may be far higher than the cost) to be recovered through direct charges and such indirect means as increased tax revenue. Project analysis, however, clearly cannot make the policy decision. Moreover, attempts to determine the proportion of government expenditure and individual benefit to be recovered under various alternative policies very quickly run into great practical difficulties. These involve estimating values, often imputed values, and more theoretical economic issues, so

that in the end cost recovery computations are of necessity more indicative than precise. Even so, cost recovery estimates based on sound economic principles can greatly improve understanding of the issues and improve the efficiency and equity of cost recovery policies.

Some aspects of cost recovery have little to do with the specifics of computation. Many countries have well-established policies about such things as water charges or taxes, policies that may not be politically possible to change all at once. Other considerations have to do with the project itself. Those projects which provide reliable service to farmers are more likely to have a better record on cost recovery than projects in which farmers feel services are poor and unreliable and, to that extent, not worth paying for.

In the final analysis, any cost recovery policy must be a political decision; it cannot be divorced from the broader sectoral and social setting. Any approach to cost recovery must be flexible and based on a recognition that what might be a good policy decision at one place or at one time is not necessarily the best decision at another place or time.

Problems of cost recovery in agricultural projects tend to be prominent in irrigation projects because these projects often are very expensive and bring proportionally large increases in income to the farmers who benefit. Much of the discussion of cost recovery, therefore, has centered around water resource projects, and the examples used in this section to illustrate methods of computation will be drawn from an irrigation project in India. The discussion here must necessarily be very general; more detailed information can be found in "Irrigation Water Charges, Benefit Taxes, and Cost Recovery Policies" (World Bank 1982b).

Objectives of cost recovery

Three basic objectives are involved in considerations of cost recovery issues: (1) economic efficiency, (2) income distribution, and (3) public saving.

Economic efficiency

The first objective concerns the level and structure of the prices to be charged-in irrigation projects, the price for water. The objective is to minimize waste and to allocate water optimally to maximize the net benefit from the project to the economy. The best way to do this would be through a price that would be equal to the contribution the water would make to increased output-an "efficiency price." This theoretical ideal is very rarely, if ever, met. It would require sale of water on a volumetric basis, which would lead to difficult problems in practice and would require estimating the contribution of water. But even a nominal price for water, perhaps one based on an acceptable if less than perfect measurement technique, would offer users an incentive to eliminate at least some of the conspicuous waste and overwatering that occur when farmers treat water as a free good. This, in turn, could reduce drainage and salinization problems.

Even if it were possible to charge farmers an optimal economic price, this might not be compatible with objectives of income distribution and public saving and investment. Hence, other criteria of assessing charges will have to be considered to ensure an equitable income effect from the project and an adequate recovery of project costs by charges that prospective beneficiaries can afford to pay and that still leave them adequate incentive to participate. Some recovery of benefits and costs will usually come from existing general taxes, such as an export tax or an income tax. But this recovery method is not geared to the circumstances of the particular project and is often unsatisfactory from the point of view of either income distribution or public savings. Moreover, capturing a larger part of the benefits and recovering more of the costs of a project through an increase in general taxation also affects those who do not directly benefit from the project. Hence, any measure to recover costs and benefits in addition to water pricing and existing general taxes should be selective and affect, to the greatest extent possible, only the project beneficiaries. These measures are usually called "benefit taxes." The most common form is a betterment levy assessed against the land benefited and perhaps varied according to the different crops grown.

Income Distribution.

The second objective of a cost recovery policy is to collect charges equitably and in line with national policy for income distribution. It may be desired to charge small farmers proportionately less than large farmers in the same project. Thus, specific taxes designed to capture part of the benefit of a project should take into account differences in income level and in the ability of beneficiaries to pay. Benefit taxes should allow for the quite different amounts of net benefit a project generates on farms quite similar in size and other characteristics. The taxes will have to be set taking into account disincentives, tax evasion, and the cost of collection. In irrigation projects, in practice only the broadest income distribution measures are implemented. A ceiling may be set on the total area an individual family may irrigate, for example, and an effort is usually made to ensure that small farmers at least do not pay a higher proportion of their benefit from the project than do larger farmers.

Public Saving

Most governments in developing countries are short of financial resources for development. Consequently, it may be desirable for the government to collect more resources than would be generated solely from efficiency pricing (which, in any case, is generally impractical) or from recovering only the cost of the project and no part of the net benefit. Not only would this make the projects financially self-supporting, but it would also enable governments to undertake additional rural development projects that would reach other members of the society. But farmers participating in a project may be poor. To recover more than the cost of the project may therefore be unacceptable, and it may be desirable to recover less.

Setting the level of water charges and benefit taxes

As the discussion to this point has indicated, the level at which to set water charges and benefit taxes will depend on a broad range of considerations. First, some estimate must be made of the net benefit received from the project by various participants. Then a system of charges and taxes must be established that captures an acceptable proportion of the benefit generated by the project while still meeting criteria of efficiency, income distribution, and equity. The level of charges and taxes must take into account similar levies in other areas and the political feasibility of charging a different amount in the project area, the disincentive effects of a benefit tax, and the administrative problems of tax collection. Benefit taxes should be designed to minimize the adverse effects these taxes may have on the production and consumption decisions of the farmers and others in the economy. It might be possible in some cases, for example, to recover costs by selling farm inputs to project beneficiaries at prices higher than those paid by others, or to purchase the output from beneficiaries at prices lower than otherwise would be paid-that is, to establish a monopolistic marketing margin. Such discriminatory taxes may induce choice of the wrong crops by farmers, although these taxes may be impossible to avoid completely. Volumetric sale in some form acceptable to farmers and project-specific betterment levies are generally better options.

The extent and manner of cost recovery directly affects the financial cash flows of the farmer, the project organization, and usually more than one government agency. Cost recovery can also affect the contribution an irrigation project will make to increasing national income. If cost recovery plans impose too heavy a burden on the farmers, the farmers may have insufficient incentive to participate fully in the project, and the anticipated output of the project will not be realized. In contrast, if cost recovery levels are set too low, the project organization may have too small an operation and maintenance budget-whether it is financed by water charges paid by farmers or by a government subsidy-so that water deliveries to farmers may be insufficient and unreliable, and production again could suffer.

The total benefit arising from the project sets a theoretical upper limit to the amount of revenue that can be collected from water charges and benefit taxes, but the actual amount collected will always be less-and usually much less-than the total benefit arising from the project. This is true simply because it is necessary to allow for errors of measurement and for the desire to increase the income of the poorest farmers. The lower limit of charges to be collected cannot be stated arbitrarily. A rule of thumb followed by many governments, however, is to attempt to establish water charges and benefit taxes that will at least recover the operation and maintenance cost. This will avoid an outright drain on current government revenues by the project. It will also reduce the

likelihood of problems arising from delays in receiving operation and maintenance funds caused by budget stringencies. There is another advantage. Where systems receive their operation and maintenance funds from the project beneficiaries, and the beneficiaries have a significant influence on the operation of the system (often through an appropriate local farmers' organization), the systems generally are fairly well managed and maintained. Past experience in World Bank projects suggests that cost recovery as a percentage of incremental net cash income rarely exceeds 30 to 35 percent.

Once established, cost recovery charges-whether water charges or benefit taxes-should be indexed so they can change in response to changing costs and to inflation. Because in new projects it is likely that farmers will need several seasons to learn to use new water efficiently, a grace period is probably appropriate during which the full water charges and benefit taxes can be phased in.

Measuring cost and rent recovery

Two measures are usually calculated to help form judgments about cost recovery. They are the cost recovery index, which gives an idea of what proportion of public expenditure on a project will be recovered directly from the beneficiaries and through taxes collected off the farm, and the rent recovery index, which gives an idea of what proportion of the total benefit will be recovered from the project beneficiaries and from other sources. These ratios are descriptive only-they should only supplement, not substitute for, an analysis of proposed water charges as they bear on efficiency, income distribution, public sector savings, and such factors as tax disincentives, costs of tax collection, broader sectoral considerations, and the political implications of any charge or tax. Furthermore, both measures depend on several values that are impossible to establish with precision, so that decisions based upon them must be treated with great caution.

Cost Recovery Index

. The first measure of cost recovery is the cost recovery index. It is:

$$\text{CRI} = \frac{\text{PV of delta water charges + PV of delta benefit taxes}}{\text{PV of incremental public sector outlays}}$$

The cost recovery index is calculated using constant market prices. The appropriate discount rate is the economic opportunity cost of capital. An example of how to calculate the cost recovery index is given in table 6-3, which is drawn from the Maharashtra II Irrigation Project in India. The first element is an estimate of the present worth of capital cost (per hectare of net cultivable "command area"-the area that can be irrigated by a particular group of irrigation works). This is based on the same cost estimates for the project as are used for other parts of the

Table 6-3. Total Cost Recovery Index, Bhima Irrigation Scheme, Maharashtra II Irrigation Project, India

Item	Amount
Present worth of capital cost (per hectare) of net cultivable command area.	
Irrigation infrastructure	18,550
Supporting works	1,850
Total	20,400
Annual financial equivalent (per hectare of net cultivable command area	
Irrigation infrastructure	1,871
Supporting works	301
Operation and maintenance	100

Table 6-3. Total Cost Recovery Index, Bhima Irrigation Scheme, Maharashtra II Irrigation Project, India

Item	Amount
Total	2,272
Cost recovery (under existing charges)	
Direct	
Incremental water charge	258
Incremental benefit tax	306
Indirect receipts	95
Total	659
Total cost recovery index (percent)	29

(Rs per hectare, constant 1979 prices)
Rs Indian rupees.

Source: Adapted from World Bank, "India, Staff Appraisal Report, Maharashtra Irrigation II Project," vol. i, "Main Report," 2529'-IN (Washington, D.C., 1979; restricted circulation), pp. 83-84.

a. For the method of calculating present worth, see chapter 9.

b. Annuity for recovery over fifty years at 10 percent interest rate. Calculated by multiplying the present worth of the capital cost of the irrigation infrastructure by the capital recovery factor for fifty years at 10 percent, which is 0.100 859, to give Rs1,871 (18,550 x 0.100 859 = 1,871).

c. Annuity for recovery over ten years at 10 percent interest rate. Calculated by multiplying the present worth of the capital cost of the supporting works by the capital recovery factor for ten years at 10 percent, which is 0.162 745, to give Rs301 (1,850 x 0.162 745 - 301).

d. Incremental benefit taxes include a tax to recover the capital cost of the supporting works, amounting to Rs301 per hectare (see note c above), and an incremental land revenue assessment of Rs5 per hectare, or a total of Rs306 (301 + 5 = 306).

e. Indirect cost recovery receipts average Rs40 per hectare for the purchase tax on sugarcane and Rs55 per hectare for the sales tax on cotton and oilseeds, or Rs95 per hectare (40 + 55 = 95).

f. Total cost recovery under existing charges divided by annual financial equivalent per hectare of net cultivable command area multiplied by 100 (659 - 2,272 x 100 = 29).

project analysis. Next, the *annual financial equivalent* (per hectare of net cultivable command area) is determined. For capital items-in this instance, the irrigation infrastructure and the supporting irrigation works-this value is calculated by multiplying the present worth of the capital cost by the capital recovery factor for the appropriate period and discount rate. [For capital recovery factors, see Gittinger (1973) or a similar set of compounding and discounting tables.] In this Maharashtra example, the irrigation infrastructure was assumed to have a life of fifty years, and the opportunity cost of capital was taken to be 10 percent, so the capital recovery factor for fifty years at 10 percent, or 0.100 859, was applied to the present worth of the irrigation infrastructure. The supporting works were taken to have a life of only ten years, so the capital recovery factor for ten years at 10 percent, or 0.162 745, was applied to them. The operation and maintenance charge, of course, is an annual charge, so it may be taken directly. Next the cost recovery is determined, in this case calculated assuming that existing charges will continue. The Maharashtra project is typical of many irrigation projects in that part of the cost recovery will come directly through water charges and a benefit tax, and part of the cost recovery will come from an indirect charge in the form of an excise tax on incremental sugarcane production and incremental sales tax revenues from marketing cotton and oilseeds. The total cost recovery index, then, is simply the total cost recovery divided by the total annual financial equivalent and multiplied by 100, which in this instance gives 29 percent (659 - 2,272 x 100 = 29).

There are variations that may be calculated, depending on the need for information on which to base cost recovery charges and benefit taxes. In the case of the Maharashtra project, for example, table 6-3 illustrates computation of the total cost recovery index, which includes as part of the cost recovery both the direct recovery through water charges and benefit taxes and the indirect recovery through excise and sales taxes. An alternative would be to calculate the direct cost recovery; that is, the amount recovered directly from the farmers themselves. In this instance the direct water charges and benefit taxes come to Rs564 per hectare (258 + 306 = 564), which would be divided by the total annual financial equivalent of Rs2,272 per hectare and multiplied by 100, so that the direct cost recovery index would be 25 percent (564 - 2,272 x 100 = 25). (The symbol for Indian rupees is Rs.)

The cost recovery index in various forms may then be used as a basis for conclusions about cost recovery policy. The effect of various levels of water charges and benefit taxes can be tested until a decision is reached about a suitable level and combination of these given such other public policy considerations as equity and the amounts charged elsewhere in the country.

Rent Recovery Indext

. The other cost recovery measure commonly calculated is the rent recovery index. It is based on projected farm budgets that are similar to those developed in chapter 4 but that have significant differences in that they include imputed values for labor, management, return to capital, and risk. In the illustrative calculation that follows, the rent recovery index for beneficiaries will be used to estimate the proportion of the benefit received by project beneficiaries that is recovered by the public authorities. The rent recovery index is:

$$\frac{\text{Incremental revenue from water + incremental benefit taxes}}{\text{Incremental economic rent accruing to project beneficiaries}}$$

Since the rent recovery index is generally computed to be used in forming a judgment about the amount of water charges and benefit taxes, it is not a discounted measure; rather, it is done for one year at the full development period. It is based on market prices.

In a general sense, the rent recovery index may be thought of as being based on the farmer's "ability to pay," his "capacity to pay," or his "repayment capacity." To calculate the rent recovery index, however, the more formal concept of "economic rent" is used. Economic rent is the surplus remaining after beneficiaries receive the rewards necessary to attract physical inputs, labor, entrepreneurship, and the willingness to bear risk. Economic rent is allied to the more familiar concept of rent as a payment for use of a capital item, but it is quite distinct from this more common use of the term "rent" and should not be confused with it.

In the case of an irrigation project, to calculate the economic rent accruing to a beneficiary, one starts with the incremental gross value of farm production, from which is deducted all incremental cash payments, incremental depreciation of farm assets, the imputed value of family labor and of management, a return on the family's own incremental capital, incremental general taxes, and an allowance for additional risk and uncertainty. Incremental water charges and incremental benefit taxes related to the project are not deducted. It will immediately be seen that estimating economic rent is not easy and is subject to a large margin of error. The various noncash and imputed values of costs cannot be determined with precision; they inevitably involve substantial judgment. It is necessary to make some estimate of this sort, however, to judge whether a sufficient proportion of the benefits received by farmers in the project is being recovered because these same elements must be considered however benefits may be measured.

An example of the computation of the rent recovery index is found in table 6-4, which is drawn from the same Maharashtra irrigation project used as an example in the previous subsection. The computation starts with the gross value of farm production at farm-gate prices without sales taxes. Of this, sales without the project amount to half, but as the family's income rises the proportion of sales rises sharply. From the gross value of farm production is deducted the cash production cost, and this gives the net benefit. This is consistent with the net benefit as defined in chapter 4 and as illustrated by the farm budget in tables 4-18 and 4-19, except for any off-farm income the family may receive. The net cash income is determined by subtracting the cash production cost from the sales. The net cash income can be compared later with any incremental water charge or benefit tax levied.

Next a group of imputed values are deducted. The first of these is depreciation. Since the rent recovery index is computed on the basis of one year at full development, depreciation must be deducted as a cost. Then an estimate of the imputed value o f family labor is deducted. This is an estimate of the wage necessary to induce the family to operate its farm. In practice, it is suggested that the analyst take the weighted average of the seasonal market wage as a proxy. Next comes an estimate

Table 6-4. Rent Recovery Index, Full Development, 5-Hectare Farm

Item	Amount		
	Without project	With project	Incremental
Gross value of farm production at farm-gate prices without sales taxes	7,500	33,380	25,880
Sales	3,750	28,380	24,630
Cash production cost	(2,690)	(11,690)	(9,000)
Gross value *less* cash production cost *equals* net benefit	4,810	21,690	16,880
Sales *less* cash production cost *equals* net cash income	1,060	16,690	15,630
Net benefit *less*			
Depreciation	0	0	0
Imputed value of family labor	(720)	(1,350)	(630)

Table 6-4. Rent Recovery Index, Full Development, 5-Hectare Farm

Item	Amount		
	Without project	With project	Incre-mental
Imputed value of management services`	(70)	(1,030)	(960)
Imputed return on own capitals	0	0	0
Allowance for risk and uncertainty'	(3,380)	(10,010)	(6,630)
General taxes	0	0	0
Equals economic rent (surplus)	640	9,300	8,660
Economic rent as a percentage of net benefit	13	43	51
Incremental water charges h	-	-	1,290
Incremental benefit taxes	-	-	1,530 T
Total incremental direct charges and benefit taxes			2,820
Rent recovery index (percent)	-	-	33

Source: Same as table 6-3.

a. May include some payment in kind for labor.

b. Since the farmer has few physical assets other than land, no depreciation was assumed.

c. An imputed value of management services equivalent to 10 percent of the net benefit less the imputed value of family labor and the allowance for risk and uncertainty rounded to the nearest Rs10. For the with-project situation, this amounts to Rs1,030 rounded to the nearest Rs10 {0.1[21,690 - (1,350 + 10,010)] = 1,033).

d. Since the family has few physical assets, no imputed return to the family's own capital was assumed.

e. Some studies of farmers' behavior show that a simple approach can be adopted to take account of the farmer's risk aversion. An allowance for risk and uncertainty is estimated based on the coefficient of variation of the gross value of farm production-the standard deviation divided by the mean-and a measure of farmers' risk aversion.

where RA is the risk allowance, EV is the expected value, v is the coefficient of variation, and n is a factor that expresses farmers' risk aversion. The studies indicate that the farmers' choice of cropping patterns and production can be predicted for values of n in the interval between 1 and 2 and that n decreases when the farm size increases. For this analysis, it is assumed that n = 1.5 for 5-hectare farms. For the project area, the coefficient of variation of gross returns under rainfed conditions is roughly 30 percent of the average value. It has been assumed that under the with-project conditions, the gross returns would vary within 20 percent of the net returns. The results were rounded to the nearest RS10. Following this approach, the allowance for risk and uncertainty in the with-project situation was estimated to be RSI0,010 rounded to the nearest Rs10 (33,380 x 1.5 x 0.2 = 10,014).

f. No general taxes are expected to be levied.

g. Economic rent divided by net benefit multiplied by 100. For the incremental net benefit this amounts to 51 percent (8,660 - 16,880 x 100 = 51).

h. Incremental direct water charges are Rs258 per hectare of net cultivable area, or Rs1,290 for the 5-hectare farm (258 x 5 = 1,290).

i. Incremental benefit taxes include a tax of Rs301 per hectare to recover the capital cost of the supporting works and an incremental land revenue assessment of Rs5 per hectare, or Rs1,530 for the 5-hectare farm [(301 + 5) x 5 = 1,5301.

j. Incremental water charges plus incremental benefit taxes.

k. Total incremental direct charges and benefit taxes divided by economic rent multi-plied by 100 (2,820 - 8,660 x 100 = 33).

of the imputed value of management services. This is a very difficult estimate to reach. In practice, project analysts take an arbitrary amount. A common estimate is 5 to 10 percent of the net benefit. In the Maharashtra project, however, the analyst took 10 percent of the net benefit less the imputed value of family labor and the allowance for risk and uncertainty. The imputed return on own capital is an estimate based on the incremental net value of assets financed by farmers out of their own savings and should reflect the rate of return that their funds could earn elsewhere. In the Maharashtra project, no imputed return on own capital was assumed because the family had relatively few physical assets. Other analysts, however, might at least have imputed a return to the family's own capital invested in land.

The next imputed value deducted is the allowance for risk and uncertainty. This is extremely difficult to formulate conceptually and notoriously difficult to estimate with confidence. Again, most project economists use a rule of thumb-a common one is 10 percent of the gross value of farm production in the first line of the table. The project analyst in the Maharashtra project used a more sophisticated approach. He based his estimate on the standard deviation of farm production in the project area and on an estimated factor that expresses the farmers' risk aversion. (The details of this computation are given in note e of table 6-4.) Most project analysts probably will have some sense of the variability of farm production in the project area for which they are preparing the analysis, and they may even have some more formal estimate such as the standard deviation. This will provide a basis for estimating the allowance for risk and uncertainty, but it will have to be substantially modified in light of the analyst's judgment about the accuracy of the estimate of variability and the willingness of farmers in the project area to accept risk. The last imputed value deducted is an estimate of the general taxes the farmer pays. These are taxes that are not specific to the project as a benefit tax would be. General taxes might include, for example, income taxes or a land tax to raise general revenue that is not linked to the project nor to improvements arising from the project investment.

When all these values have been deducted, the remainder is an estimate of the economic rent (surplus) accruing to the farmer. It is thus an estimate of the surplus remaining for the farmer after paying the rewards necessary to attract the physical inputs, labor, entrepreneurship, and willingness to bear risk necessary to operate the farm-the definition of economic rent above. The economic rent as a percentage of net benefit, the next entry in the table, relates economic rent to the net benefit received by the farmer, which for the incremental net benefit amounts to 51 percent (8,660 - 16,880 x 100 = 51).

Next are entered the proposed incremental water charges and incremental benefit taxes that the farmer is expected to pay. Dividing the total of these by the economic rent gives the rent recovery index. This is an estimate of the proportion of the surplus the farmer receives over and above the minimum necessary to induce him to participate in the project that will be recaptured by the public authorities. In the case of the Maharashtra project, this recovery amounts to 33 percent of the economic rent [(1,290 + 1,530) - 8,660 x 100 = 33].

This discussion of the rent recovery index has highlighted the many elements of the estimate that can be approximate at best. Hence, the rent recovery index, although very useful as an aid for setting cost recovery policy, must be used with caution.

As with the cost recovery index, there are variations of the rent recovery index that give insight into other questions about a project. A common variation is to estimate the rent recovery index for the project (as opposed to that for the beneficiaries, as illustrated in table 6-4). For this the project rent must be estimated. Essentially the same elements are used as discussed above, except that the concept of the incremental benefit tax is expanded to include not only benefit taxes collected directly from the beneficiary but also taxes arising from the incremental output due to the project but collected off the farm. These include, in the case of the Maharashtra project, the excise tax on sugarcane and the sales tax on cotton and oilseeds. In other cases they might include an export tax or the net increase in a marketing board margin (technically, in the monopolistic marketing margin) arising from handling incremental production from the project area. In general, estimates of project rent are made for each major farm pattern, and the results are aggregated to the project level. Since the incremental benefit taxes include taxes and marketing margins arising off the farm, the project rent recovery index will be higher than the weighted average of the beneficiary economic rent received by the individual farmers. In the case of the Maharashtra project, for instance, the rent recovery index for the individual farm pattern analyzed in table 6-4-33 percent-rises to 40 percent for the Bhima scheme as a whole (including pattern farms other than the one represented in table 6-4) because the additional taxes are included.

Another variation of the rent recovery index is to calculate it, for either beneficiaries or the project, on a discounted basis. This provides a means to estimate on the basis of present worth the proportion of the benefit of a project captured by the public authorities. This is useful from a public policy standpoint, but is not a suitable basis on which to determine the level of water charges and benefit taxes at full development. From a public policy standpoint, one can then test varying assumptions about water charges and benefit taxes until a rent recovery index is reached that is considered to be equitable given the income of the farmers in the project and the charges levied elsewhere in the country.

Joint Cost Allocation

When a government undertakes to implement a multipurpose project, a problem arises about how to allocate the cost of the project among the various beneficiaries. The complication arises, of course, because there are joint costs in a multipurpose project, costs that cannot clearly be attributed to one purpose or another. A technique often used to allocate joint cost-especially in multipurpose water development projects, but by no means limited only to them-is that known as the "separable costs-remaining benefits" method.

We will discuss joint cost allocation using market prices and as a financial problem, since this is by far the most common practice. The same techniques we will outline, however, can be applied to economic values, and in some cases this may be more appropriate. In the Senegal River Development Program we will use as an example for joint cost allocation, the prices for agricultural commodities were indeed taken not as the internal administered prices actually paid farmers but as the border prices at world market values-already a step away from strict financial analysis and toward economic values and the use of shadow prices. This was done because the major objective of the analysis was to determine a fair cost allocation among the participating nations, not to determine equitable financial charges to levy on benefiting farmers.

General principles of cost allocation

There are several general principles or guidelines of joint cost allocation that underlie the rationale of the separable costs-remaining benefits method.

In general, no project purpose should be assigned a cost that is in excess of the value of its benefit nor be supported by the benefit of another purpose. Thus, the charge for irrigation water should not be greater than the contribution of that water to the benefit of the project. Similarly, in general we feel that no purpose should be subsidized by another purpose. Power users in most cases should not be charged high rates to make irrigation water available at low cost to farmers.

All the cost incurred for one purpose only should be allocated wholly to that purpose. The cost of canals is wholly allocated to the irrigation purpose, and the cost of the transmission lines wholly to the power purpose. Each "separable cost" is the minimum that can be charged for the respective purpose. If the cost of the canals alone exceeds the benefit from the irrigation water, then clearly the project should not include an irrigation component.

No purpose, however, should be assigned a cost that is any greater than would be incurred if that function were to be supplied by the most economic alternative single-purpose project. The alternative single-purpose project establishes the maximum that can be charged for any one purpose. It is not equitable to allocate to the power component of a

multipurpose water development project a cost more than that of the alternative thermal plant that could provide the same electrical service, nor is it equitable to charge the irrigation component more than the cost of an alternative single-purpose pumping scheme.

Separable costs-remaining benefits method

The application of the separable costs-remaining benefits method is illustrated by the Senegal River Development Program cost allocation in table 6-5. The three West African states of Mali, Mauritania, and Senegal have formed the Senegal River Development Organization (known by the initials of its French name, omvs) to plan and develop a multipurpose project on the Senegal River. In the configuration for which the joint cost allocation is outlined as an example, the project would consist of the multipurpose Manantali Dam on the Bafing River, a major tributary of the Senegal River, to provide a regulated flow; the Diama Dam close to the mouth of the river to prevent upstream intrusion of salty ocean water; a power generation station with associated distribution network at the Manantali Dam; and navigation improvements to permit year-round service to Mali. The benefits of the project are (1) increased production of agricultural crops because of double cropping in the dry season and better water regulation in the wet season, (2) power, and (3) reduced transport costs because of the navigation improvements. [This example is adapted from Riley and others (1978).]

We will follow the analysis line by line. The first part of table 6-5 summarizes the basic information about the project that will be needed to allocate cost. The technical information would be supplied by the engineers and the other technicians; the cost and benefit would be estimated by the technical staff working with the economists.

We begin with the project cost to be allocated (line 1.1). This is the total cost for the project as a whole that is to be allocated among the three purposes. Included are both the construction cost (line 1.1.1), stated at its present worth as of the beginning of the project, and the annual operation and maintenance cost (often abbreviated in project accounts as o&m; line 1.1.2) necessary to operate the project.

The annual project benefit for each purpose is listed and the total of these is entered (line 1.2). In the Senegal River case, the power benefit was assumed to be the amount for which the power could be sold. In most instances, however, the power benefit would be assumed to be the annual cost of providing the same amount of electricity by means of the most economic single-purpose alternative project-always assuming that consumers would purchase electricity at that price. This simplification avoids the problems associated with valuing electricity. It implies that the real benefit of power-whatever that might beis greater than the cost of the single-purpose alternative. The effect of this assumption is to set the maximum that can be charged for power to equal the benefit of the most economic alternative single-purpose project, which is what the analytical technique would do in any case.

Next is listed the alternative cost for each purpose (line 1.3), both for construction, stated at its present worth (line 1.3.1), and for the annual operation and maintenance charge (line 1.3.2). As noted, an alternative cost is the cost of the most economic single-purpose project that could provide one of the same benefits provided by the multipurpose project. An alternative does not have to be located at the multipurpose site, but it should be capable of producing its benefit in essentially the same geographic area as the one in which the benefit from the multipurpose project is to be utilized. The alternative project may be of an entirely different physical nature, as would be the case if the alternatives to a multipurpose river development were pump irrigation and a thermal generating plant. Of course, the most economic single-purpose alternative might cost more than the benefit it would generate; even the most economic alternative might not be justified as a separate project.

Next is the separable cost (line 1.4) given by purpose, both for construction at present worth (line 1.4.1) and for the annual operation and maintenance charge (line 1.4.2). Separable cost is expenditure that could be avoided if one purpose were excluded from the project. It is possible to find that no portion of the joint cost is solely and clearly traceable to a particular purpose. In measuring the separable cost, each purpose should be treated as if it were the last increment added to a project that serves all the other multiple purposes; in this way favoring one purpose over another may be avoided.

In many projects, the annual figures such as those for the operation and maintenance cost and annual benefit in the Senegal River example would not be constant during the life of the project. In these instances, the present worth of the cost or benefit stream would be substituted because that is what is called for in the joint cost allocation in the second part of table 6-5. Indeed, Riley and his colleagues (1978) do treat both operation and maintenance cost and annual benefit in this manner in the report from which this example is drawn.

The discount rate (line 1.5) is either the financing cost of the project if the project is to be constructed using loan funds or the government borrowing rate if the project is to be financed from allocations in the current government budget.

The project life (line 1.6) and the length of the construction period (line 1.7) are part of the technical data supplied by those responsible for designing the project. Carrying out the analysis for a very long period, however, has little meaning because of the very small present worth of values assumed in the distant future. In the Senegal River project, for example, the physical facilities would probably last much longer than the thirty-year period chosen for analysis, but extending the period of analysis would hardly affect the joint cost allocation.

The last part of tabulating the basic information for the joint cost allocation is to derive the factors for converting between annual values and present worth. The factor to convert annual cost or benefit to present worth (the present worth of an annuity factor; line 1.8) is computed for the discount rate as indicated. (The method of deriving the present worth

of an annuity factor for a period beginning in the future is discussed in chapter 9, under "The Time Value of Money. Present worth of a stream of future income.") The factor to convert present worth of cost or benefit to annual cost (capital recovery factor) for a period beginning some time in the future (line 1.9) cannot be computed directly from the capital recovery factors given in standard tables in a manner similar to the computation of the present worth of an annuity factor. This problem may be avoided, however, by taking advantage of the fact that the capital recovery factor for any period is the reciprocal of the present worth of an annuity factor for that period. Thus, we find that the capital recovery factor for the tenth through the thirtieth year at 10 percent is 0.272 636 (1 - 3.667 890 = 0.272 636).

Table 6-5. Joint Cost Allocation,Senegal River Development Program, West Africa (millions of CFAF)

Line and item	Irrigation	Power	Navigation	Total
1. Basic information				
1.1 Project cost to be allocated				
1.1.1 Construction (at present worth)				41,464
1.1.2 Annual o&na				449
1.2.Annual project benefit	25,707	14,035	21,820	61,652
1.3.Alternative cost				
1.3.1 Construction (at present worth)	16,120	5,233	23,980	45,333
1.3.2 Annual o&m	152	3,060	223	3,435
1.4.Separable cost				
1.4.1 Construction (at present worth)	5,494	5,424	7,867	18,785
1.4.2 Annual O&M	55	109	75	239
1.5.Discount rate: 10 percent				
1.6.Project life: 30 years				
1.7.Construction period: 9 years				
1.8.Factor to convert annual cost or benefit to present worth (present worth of an annuity factor):				
Present worth of an annuity factor for 30 years at 10 percent 9.426 914			9.426914	
Less present worth of an annuity factor for 9 years at 10 percent			-5.759024	

Table 6-5. Joint Cost Allocation,Senegal River Development Program, West Africa (millions of CFAF)

Line and item	Irrigation	Power	Navigation	Total
Present worth of an annuity factor for 10th through 30th years at 10 percent			3.667890	
1.9. Factor to convert present worth of cost of benefit to annual cost (capital recovery factor):				
Capital recovery factor Reciprocal for 10th through 30th years at 10 percent		Reciprocal of present worth factor	1/3.667890	.272636
2. Joint cost allocation (all values at present worth except distribtuion percentage)				
2.1. Cost to be allocated				
2.1.1 Construction (1.1.1)				41,464
2.1.2 o&m [0.1.2) x 3.667 890]				1,647
Total [(2.1.1) + (2.1.2)]				43,111
2.2. Benefit [(1.2) x 3.667 8901	94,290	51,479	80,033	225,802
2.3 Alternative cost				
2.3.1 Construction (1.3.1)	16,120	5,233	23,980	45,333
2.3.2 o&m [(1.3.2) x 3.667 890]	558	11,224	818	12,600
Total [(2.3.1) + (2.3.2)]	16,678	16,457	24,798	57,933
2.4. Justifiable expenditure [lesser of				
(2.2) or (2.3)]	16,678	16,457	24,798	57,933
2.5. Separable cost				
2.5.1 Construction (1.4.1)	5,494	5,424	7,867	18,785
2.5.2 o&m [(1.4.2) x 3.667 8901	202	400	275	877
Total [(2.5.1) + (2.5.2)]	5,696	5,824	8,142	19,662
2.6. Remaining justifiable expenditure				
[(2.4) - (2.5)]	10,982	10,633	16,656	38,271
2.7. Percentage distribution of (2.6)	28.70	27.78	43.52	100.00
2.8. Remaining joint cost [total from				
lines indicated allocated according				
to (2.7)]				
2.8.1 Remaining construction cost				
[(2.1,1) - (2.5.1)]	6,509	6,300	9,870	22,679

Table 6-5. Joint Cost Allocation,Senegal River Development Program, West Africa (millions of CFAF)

Line and item	Irrigation	Power	Navigation	Total
2.8.2 Remaining o&m				
[(2.1.2) - (2.5.2)]	221	214	335	770
Total [(2.8.1) + (2.8.2)]	6,730	6,514	10,205	23,449
2.9. Total allocated cost				
2.9.1 Construction cost				
[(2.5.0 + (2.8.1)]	12,003	11,724	17,737	41,464
2.9.2 o&m [(2.5.2) + (2.8.2)]	423	614	610	1,647
Total [(2.9.1) + (2.9.2)]	12,426	12,338	18,347	43,111
3. Annual costs				
3.1. Annual cost				
3.1.1 Construction[(2.9.1) x 0.272 636]	3,272	3,196	4,836	11,304
3.1.2 o&m [(2.9.2) x 0.272 6361	115	167	166	448
Total [(3.1.1) + (3.1.2)]	3387	3363	5002	11752

CFAF African Financial Community francs.
Source: Adapted from Riley and others (1978).

a. o&m Operation and maintenance cost.

b. The annual cost does not exactly equal the allocated cost times the capital recovery factor because of rounding.

The second part of table 6-5 lays out the computation of the joint cost allocation. Note that all values (except the distribution percentages) are stated in their present worth equivalents.

The cost to be allocated (line 2.1) is the total cost of the project, obtained by adding the construction cost at present worth (line 2.1.1), taken from line 1.1.1, and the present worth of the operation and maintenance cost for the project (line 2.1.2), computed by taking the value of CFAF449 million supplied in line 1.1.2 and multiplying it by the present worth of an annuity factor for the tenth through the thirtieth years, which gives CFAF1,647 million (449 x 3.667 890 = 1,647). (The symbol for African

Financial Community francs is CFAF.) It is this cost that is to be allocated among the various purposes.

The benefit (line 2.2) is the annual project benefit given in line 1.2 multiplied by the present worth of an annuity factor for the tenth through the thirtieth years. Thus, the present worth of the irrigation benefit stream over the life of the project is CFAF94,290 million (25,707 x 3.667 890 = 94,290).

The alternative cost (line 2.3) lists the total costs for the most economic alternative single-purpose projects with the same benefit as the appropriate components of the multipurpose project. The subentries that are added for the total are taken from the first part of the table: the alternative construction cost (line 2.3.1) is given in line 1.3.1; the operation and maintenance cost for the alternative single-purpose projects (line 2.3.2) is taken from the annual operation and maintenance cost in line 1.3.2 and is converted to present worth using the present worth of an annuity factor.

The justifiable expenditure for each purpose (line 2.4) is either the benefit on line 2.2 or the total alternative cost on line 2.3, whichever is less. The sum of the justifiable expenditure for the various purposes is the total justifiable expenditure for the multipurpose project; this amount is entered in the total column of line 2.4. We noted this earlier: the amount to be allocated to a particular purpose is limited on the one hand by the benefit it will produce and on the other hand by the cost of the most economic single-purpose alternative.

The separable cost (line 2.5) is taken from the first part of the table. The separable construction cost for each purpose (line 2.5.1) comes from line 1.4.1. The present worth of the separable annual operation and maintenance cost (line 2.5.2) is derived by multiplying the value in line 1.4.2 by the present worth of an annuity factor. The separable cost is then totaled. In general, the total separable cost for each purpose will be the minimum allocation that will be charged to that purpose.

To determine the remaining justifiable expenditure (line 2.6) for each purpose and for the project as a whole, the separable cost of each purpose given in line 2.5 is deducted from the justifiable expenditure given in line 2.4. In the case of the irrigation purpose, for example, the separable cost of CFAF5,696 million is subtracted from the justifiable expenditure of CFAF16,678 million, and this leaves a remaining justifiable expenditure of CFAF10,982 million (16,678 - 5,696 = 10,982). Of course, if the value for any purpose is negative, it means that the present worth of the benefit at the discount rate being used is less than the present worth of the cost. If one purpose is not to subsidize another, then any purpose with a negative justifiable expenditure should be omitted from the project.

The percentage distribution of the remaining justifiable expenditure in line 2.6 is calculated and entered in line 2.7.

Now we must calculate the remaining joint cost for each purpose (line 2.8). This is done by allocating the joint cost of the project to each purpose in proportion to the excess over the separable cost that we would be justified in spending to realize the benefit from each purpose. We begin by determining the total remaining (joint) construction cost in the last column of line 2.8.1. To do this, the total separable construction cost for the entire project in the last column of line 2.5.1 is subtracted from the total construction cost for the entire project in line 2.1.1 to give the total remaining joint construction cost of CFAF22,679 million, which then is entered in the last column of line 2.8.1 (41,464 - 18,785 = 22,679).

Similarly, the total remaining (joint) operation and maintenance cost in the last column of line 2.8.2 is determined by subtracting the separable operation and maintenance cost in line 2.5.2 from the total operation and maintenance cost in line 2.1.2. This gives a value of CFAF770 (1,647 - 877 = 770). These totals are then allocated to the various purposes according to the percentage distribution of the remaining justifiable expenditure in line 2.7. Thus, the remaining construction cost for irrigation is 28.70 percent of CFAF22,679, or CFAF6,509 (22,679 x 0.2870 = 6,509), and the remaining operation and maintenance cost for power is 27.78 percent of CFAF770, or CFAF214 (770 x 0.2778 = 214). The total of the remaining joint cost for each purpose is the sum of the remaining joint cost for construction (line 2.8.1) and operation and maintenance cost (line 2.8.2).

The total allocated cost (line 2.9) may now be determined. The total allocated construction cost (line 2.9.1) for each purpose is determined by adding the separable construction cost for that purpose in line 2.5.1 to the remaining joint construction cost in line 2.8.1. Thus, the total allocated construction cost for the irrigation component is CFAF12,003 million-(5,494 + 6,509 = 12,003). Similarly, the total allocated operation and maintenance cost for each purpose (line 2.9.2) is the sum of the separable operation and maintenance cost for that purpose in line 2.5.2 and the remaining joint operation and maintenance cost in line 2.8.2. Hence, the total allocated operation and maintenance cost for the irrigation purpose is CFAF423 million (202 + 221 = 423). The sum of the total allocated construction cost for each purpose and the total allocated operation and maintenance cost for each purpose is the total allocated cost for each purpose. Of course, the total allocated cost in the last column of line 2.9 must equal the total cost to be allocated in the last column of line 2.1, and this provides an internal check on the calculations.

The third part of table 6-5 gives the annual costs. The annual cost (line 3.1) for each purpose is determined by multiplying the total allocated cost in line 2.9 by the capital recovery factor for the tenth through the thirtieth year at 10 percent as computed in the first part of the table. Thus, the annual cost for navigation is determined by multiplying the total allocated cost by the capital recovery factor to obtain the annual cost of CFAF5,002 million (18,347 x 0.272 636 = 5,002). Because of rounding, the annual costs for irrigation and power do not quite check when calculated in this manner. In table 6-5 the total annual cost (line 3.1) is shown as the total of the annual construction and annual operation and maintenance costs. The annual construction cost (line 3.1.1) and the annual operation and maintenance cost (line 3.1.2) may be determined separately as explained above. Thus, the annual construction cost for irrigation is CFAF3,272 million (12,003 x 0.272 636 =

3,272), and the annual operation and maintenance cost chargeable to irrigation is CFAF115 million (423 x 0.272 636 = 115). An equitable annual charge for the use of irrigation water in the project would thus be CFAF3,387 million, of which CFAF3,272 million would go toward the construction cost and CFAF115 million would be for operation and maintenance cost (3,272 + 115 = 3,387). If it were determined that the governments were to bear the capital cost of irrigation and the farmers to pay only the operation and maintenance cost, the farmers would have to pay only the CFAF115 million annual operation and maintenance charge. (In the Senegal River project, there would be additional cost to bring the water from the river to the fields, but this falls outside the project cost as such.)

Note that the separable costs-remaining benefits method when calculated using market prices only specifies what would be an equitable financial charge using as a sole criterion the cost incurred for each purpose and the benefit generated by each purpose. What the beneficiaries actually will be charged depends on many other considerations, as noted in the previous section on cost recovery. Sometimes, for example, the capital cost for irrigation will be assumed by the treasury and be paid from general tax revenues, but farmers will be assessed enough to pay for the operation and maintenance cost. Other services may also not be charged precisely the amounts the separable costs-remaining benefits method indicates as equitable. Often, for example, no charge is levied for flood control benefits that are paid for from the general revenue, and it is likely that power users will be charged the prevailing rate for the area served by the multipurpose project and not the rate determined by the annual cost of the project power component.

We have covered the primary elements of joint cost allocation in this discussion. Readers who wish to go further might consult the report prepared by Riley and his group (1978) from which the Senegal River example is drawn; the report includes variations on the allocation method outlined here as well as interesting discussions of valuing benefit and allocating cost equitably between countries. A more extensive discussion of joint cost allocation will be found in James and Lee (1970), and Loughlin (1977) proposes a modification of the separable costs-remaining benefits methodology to increase the equity by applying weights for the relative amounts of the separable cost assigned to each purpose.

7. DETERMINING ECONOMIC VALUES

Once financial prices or costs and benefits have been determined and entered in the project accounts, the analyst estimates the economic value of a proposed project to the nation as a whole. The financial prices are the starting point for the economic analysis; they are adjusted as needed to reflect the value to the society as a whole of both the inputs and outputs of the project.

When the market price of any good or service is changed to make it more closely represent the opportunity cost (the value of a good or service in its next best alternative use) to the society, the new value assigned becomes the "shadow price" (sometimes referred to as an "accounting price"). In the strictest sense, a shadow price is any price that is not a market price, but the term usually also carries the connotation that it is an estimate of the economic value of the good or service in question, perhaps weighted to reflect income distribution and savings objectives.

In chapter 2, for purposes of project analysis, we took the objective of a farm to be to maximize the farm family's incremental net benefit, the objective of the firm to maximize its incremental net income, and the objective of the society to maximize the contribution a project makes to the national income-the value of all final goods and services produced in the country during a particular period. These objectives, and the analysis to test their realization, were seen in financial terms for farms and firms. But economic analysis of a project moves beyond financial accounting. Strictly speaking, we may say that in financial analysis our numeraire-the common yardstick of account-is the real income change of the entity being analyzed valued in domestic market prices and in general expressed in domestic currency. But in economic analysis, since market prices do not always reflect scarcity values, our numeraire becomes the real, net national income change valued in opportunity cost. As we will note below, one methodology expresses these economic values in domestic currency and uses a shadow price of foreign exchange; the shadow price increases the value of traded goods to allow for the premium on foreign exchange arising from distortions caused by trade policies. Another method in use expresses the opportunity cost value of real national income change in domestic currency converted from foreign exchange at the official exchange rate and applies a conversion factor to the opportunity cost or value in use of nontraded goods expressed in domestic currency; the conversion factor reduces the value of nontraded goods relative to traded goods to allow for the foreign exchange premium.

Before a detailed discussion of adjusting financial accounts to reflect economic values commences, an important practical consideration must be emphasized. Many of the adjustments to the financial accounts can become quite complex. Not every point made in this chapter will apply to every agricultural project, nor will all points have the same importance in those projects where they do apply. The complexity of some calculations and the relative importance of some adjustments recall the reason for undertaking an economic analysis of a project: to improve the investment decision. Some adjustments will make a considerable difference to the economic attractiveness of a proposed project; others will be of minor importance, and no reasonable adjustment would change the investment decision. What we need to do here is to adopt an accounting practice-the doctrine of materiality. The analyst must focus his attention on those adjustments to the financial accounts that are likely to make a difference in the project investment decision. He should use rough approximations or ignore trivial adjustments that will not make any difference in the decision. There is an important balance to be struck between analytical elegance and getting on with the job.

In this chapter we will adjust the financial prices of tangible items to reflect economic values in three successive steps: (1) adjustment for direct transfer payments, (2) adjustment for price distortions in traded items, and (3) adjustment for price distortions in nontraded items. Before embarking on this series of adjustments, we will examine the problem of determining the appropriate premium for foreign exchange. After completing the adjustments, we will summarize the main points in a "decision tree" for determining economic values.

The series of successive adjustments to the financial accounts will lead to a set of economic accounts in which all values are stated in "efficiency prices," that is, in prices that reflect real resource use or consumption satisfaction and that are adjusted to eliminate direct and indirect transfers. These values will be market prices when market prices are good estimates of economic value or they will be shadow prices when market prices have had to be adjusted for distortions. When we adjust financial prices to reflect economic values better, in the vast majority of cases we will use the opportunity cost of the good or service as the criterion. We will use opportunity costs to value all inputs and outputs that are intermediate products used in the production of some other good or service. For some final goods and services, however, the concept of opportunity cost is not applicable because it is consumption value that sets the economic value, not value in some alternative use. In these instances, we will adopt the criterion of "willingness to pay" (also called "value in use"). We need to do this, however, only when the good or service in question is nontraded (perhaps as a result of government regulation) during some part of the life of the project-a point to which we will return later in our discussion. Because the ultimate objective of all economic activity is to satisfy consumption wants, all opportunity costs are derived from consumption values, and thus from willingness to pay.

An example may clarify our use of willingness to pay and opportunity cost. Suppose a country that is a rather inefficient producer of sugar has a policy to forbid sugar imports to protect its local industry. The price of sugar may then rise well above what it would be if sugar were imported. Even at these higher prices, most consumers will still buy some sugar for direct consumption-say, in coffee or tea-even though they may use less sugar than if the price were lower. The domestic price of sugar will be above the world market price and will represent the value of the sugar by the criterion of willingness to pay. If we were now to consider the economic value of sugar from the standpoint of its use in making fruit preserves, its value would become the opportunity cost of diverting the sugar from direct consumption, where willingness to pay is the criterion and has set the economic value.

Economic analysis, then, will state the cost and benefit to the society of the proposed project investment either in opportunity cost or in values determined by the willingness to pay. The costs or values will be determined in part by both the resource constraints and the policy constraints faced by the project. The difference between the benefit and the cost-the incremental net benefit stream-will be an accurate reflection of the project's income-generating capacity-that is, its net contribution to real national income.

The system outlined here will make no adjustment for the income distribution effects of a proposed project nor for its effect on the amount of the benefit generated that will be invested to accelerate future growth. Rather, the economic project analysis, stated in efficiency prices, will judge the capacity of the project to generate national income. The analyst can then choose from those alternative projects (or alternative formulations of roughly the same project) the high-yielding alternative that in his subjective judgment also makes the most effective contribution to objectives other than maximizing national income-objectives such as income distribution, savings generated, number of jobs produced, regional development, national security, or whatever. The choice about the *kind* of project will of course be made rather early in the project cycle. Thus, it may be determined early on that for reasons of social policy a project will be preferred that encourages smallholder agriculture rather than plantations. Then, the choices will likely be several projects or variants of projects that encourage smallholders; the analytical technique presented here can determine from among the projects that will further the desired social objective the ones that are more economically efficient.

Although the system outlined here makes no adjustment for income distribution effects or for saving versus consumption, it is compatible with other analytical systems that do. In particular, Squire and van der Tak *(1975)* recommend evaluating proposed projects first by using essentially the same efficiency prices that will be estimated here and then by further adjusting these prices to weight them for income distribution effects and for potential effects on further investment of the benefits generated. The systems in Little and Mirrlees *(1974)* and the uxmo *Guidelines for Project Evaluation (I 972a),* with minor departures, also propose evaluating the project by first establishing its economic accounts in efficiency prices and then by adjusting these accounts to weight them for income distribution and savings effects. Making allowances for income distribution and savings effects involves somewhat more complex adjustments than those necessary to estimate efficiency prices; it also unavoidably incorporates some element of subjective judgment. Although these systems have attracted widespread interest among economists, their application has been only partial or on a limited scale. The system of economic analysis using efficiency prices that is outlined here is essentially the one currently used for all but a few World Bank projects and also the one used for most analyses of projects funded by other international organizations.

The economic analysis follows on the financial analysis presented in the preceding chapters; it will be based on projected farm budgets similar to those in chapter *4,* on projected accounts for commercial firms such as those in chapter *5,* and on projected government cash flows such as those in chapter 6. Since these accounts are projected for the life of the project, there will be no separate allowance for depreciation. Instead, as noted earlier, the costs will have been entered in the years they are incurred and the returns in the year they are realized.

In the economic analysis, we will want to work with accounts cast on a constant basis; thus we will want to be sure that any inflation contingency allowances have been taken out. As noted in chapter *2,* however, physical contingency allowances and contingency allowances intended to allow for *relative* price changes are properly incorporated in the economic accounts, even when the accounts are in constant prices. Of course, any of the items included among the contingencies may be revalued, if necessary, to adjust them from their market prices to economic values. The projected financial accounts will usually not have any entry for cash. Instead, they will show separately the cash position of the farmer or note a cumulative cash surplus or deficit. It is possible, however, that some accounts may have a cash balance included in an entry for working capital or the like. If such an entry exists, it must be removed from the economic analysis; since we will be working on a real basis in the economic accounts, we will show real costs when they occur and real benefits when they are realized.

Determining the Premium on Foreign Exchange

Adjusting the financial accounts of a project to reflect economic values involves determining the proper premium to attach to foreign exchange. That determination quickly involves issues of obtaining proper values and of economic theory. Fortunately for most agricultural project analysts, the answer to the question about how to determine the foreign exchange premium is simple (and simplistic): ask the central planning agency. The point is that if various alternative investment opportunities open to a nation are to be compared, the same foreign exchange premium must be used in the economic analysis of each alternative. Otherwise we will be mixing apples and oranges and cannot use our analysis reliably to choose among alternatives. Sometimes, however, the analyst will be forced to make his own estimate of the foreign exchange premium. A practical approach, along with some of the theoretical and applied problems of the computation, is given by Ward (1976). Little and Mirrlees (1974), Squire and van der Tak (1975), and the UNIDO Guidelines (1972a) also outline in considerable detail how to make the conversion between foreign exchange and domestic currency when their analytical systems are used.

The need to determine the foreign exchange premium arises because in many countries, as a result of national trade policies (including tariffs on imported goods and subsidies on exports), people pay a premium on traded goods over what they pay for nontraded goods. This premium is not adequately reflected when the prices of traded goods are converted to the domestic currency equivalent at the official exchange rate. The premium represents the additional amount that users of traded goods, on an average and throughout the economy, are willing to pay to obtain one more unit of traded goods. Since all costs and benefits in economic analysis are valued on the basis of opportunity cost or willingness to pay, it is the relation between willingness to pay for traded as opposed to nontraded goods that establishes their relative value.

The premium people are willing to pay for traded goods, then, represents the amount that, on the average, traded goods are mispriced in relation to nontraded items when the official exchange rate is used to convert foreign exchange prices into domestic values. By applying the premium to traded goods, we are able to compare the values of traded and nontraded goods by the criterion of opportunity cost or willingness to pay. Although this premium is commonly referred to as the foreign exchange premium, it should be recognized that the premium is actually a premium for traded goods; foreign exchange itself has no intrinsic value. The premium for traded goods is a premium on the particular "basket" of traded goods that the present and projected trade pattern implies. Of course, future patterns of trade could change the exact composition of the basket, and thus the premium would change; to estimate these changes involves a knowledge of elasticities-the way demand and supply of goods and services vary when prices change-that is generally not available. Where such elasticities are known, it is possible for a well-trained economist to provide the project analyst with a more accurate estimate of the expected premium on foreign exchange.

If traded items were to be taken into the project analysis at an economic value obtained by simply multiplying the border price by the official exchange rate without adjusting for the foreign exchange premium, imported items would appear too cheap and domestic items too dear. This would encourage overinvestment in projects that use imports. For example, if combine harvesters look cheap because no allowance is made for the premium on traded goods, then imported combines might displace local harvest labor, even though the local labor might have no other opportunities for employment.

There are two equivalent ways of incorporating the premium on foreign exchange in our economic analysis. The first is to multiply the official exchange rate by the foreign exchange premium, which yields a shadow foreign exchange rate. [Note that this derivation of the shadow exchange rate is appropriate for efficiency analysis of projects and thus has a discrete definition. Other definitions of the shadow exchange rate are appropriate depending on the uses to which the rate will be put. Bacha and Taylor

(1972) discuss some of these alternatives.] The shadow exchange rate is then used to convert the foreign exchange price of traded items into domestic currency. The effect of using the shadow exchange rate is to make traded items relatively more expensive in domestic currency by the amount of the foreign exchange premium. (An alternative arithmetic formulation is to convert the foreign exchange price into domestic currency at the official exchange rate and then multiply by 1 plus the foreign exchange premium stated in decimal terms.) The shadow exchange rate approach has been used in the past in most World Bank projects when adjustments have been made to allow for the foreign exchange premium on traded goods, and it is also used in the UNIDO Guidelines (1972a).

An alternative way to allow for the foreign exchange premium on traded items that is increasingly coming into use is to reduce the domestic currency values for nontraded items by an amount sufficient to reflect the premium. This is sometimes called the "conversion factor" approach. In its simplest form, based on straightforward efficiency prices, a single conversion factor-the "standard conversion factor" of Squire and van der Tak-is derived by taking the ratio of the value of all exports and imports at border prices to their value at domestic prices (Squire and van der Tak 1975, p. 93). In this form, the standard conversion factor bears a close relation to our shadow exchange rate; indeed, the standard conversion factor may be determined by dividing the official exchange rate by the shadow exchange rate or by taking the reciprocal of 1 plus the foreign exchange premium stated in decimal terms. Market prices or shadow prices of nontraded items are then multiplied by this standard conversion factor, and this reduces them to their appropriate economic value. Little and Mirrlees and Squire and van der Tak both adopt the conversion factor approach. In addition, both pairs of authors recommend deriving specific conversion factors for particular groups of products that will allow for any difference between market prices and opportunity costs and for the foreign exchange premium on traded items. As a result, their specific conversion factors may always be applied directly to domestic market prices. These authors also recommend that their conversion factors be calculated in social prices by including distribution weights.

In the valuation system followed here, all items are valued at efficiency prices without allowance for distribution weights (the issue of selecting projects to achieve distributional objectives is treated as a subsequent decision). This being the case, consideration of the distribution-weighted conversion factors proposed by Little and Mirrlees and Squire and van der Tak may be left aside, and we may focus our discussion on the Squire and van der Tak standard conversion factor as it relates to efficiency prices.

The relation between the official exchange rate (in the equations below, OER), the foreign exchange premium (Fx premium), the shadow exchange rate (SER), and the standard conversion factor (SCF) is perhaps easier to understand in equation form:

so that, as Squire and van der Tak note (1975, p. 93), We may illustrate these relations by an example taken from the Agricultural Minimum Package Project in Ethiopia. At the time the project was appraised, the analyst knew that the official exchange rate of Eth$2.07 = US$1 failed to account for a foreign exchange premium of at least 10 percent. (The symbol for the Ethiopian dollar is Eth$; since this project was appraised the name of the currency unit has been changed to birr.) Thus, the analyst multiplied the official exchange rate by 1 plus a 10 percent foreign exchange premium to obtain a shadow exchange rate of Eth$2.28 = US$1 (2.07 x 1.1 = 2.28) that he rounded up to Eth$2.30 = US$ 1. The shadow exchange rate was then applied to all'traded items in the financial accounts, thereby increasing their relative value.

If the domestic currency is worth more per unit than the foreign exchange, the arithmetic is somewhat different. At the time the Nucleus Estate/Smallholder Oil Palm Project in Rivers State, Nigeria, was appraised, the official exchange rate was N 1 = US$1.54. (The symbol for Nigerian naira is N.) The project analysts were given a shadow exchange rate of N1 = US$1.27 to use in their economic evaluation. If, however, they had simply been informed that the foreign exchange premium was 21 percent, they could have determined the shadow exchange rate by dividing the dollar value by 1 plus the premium stated in decimal terms (1.54 - 1.21 = 1.27).

Of course, the effect of applying the shadow exchange rate to the traded items in the Ethiopian project was to make all nontraded items 10 percent less expensive in relation to the traded items in the economic accounts as opposed to the financial accounts. Now, instead of increasing the relative value of traded items, we could reduce the value of all nontraded items appearing in the financial accounts so that in the economic account they are relatively 10 percent less expensive. To do this we calculate the standard conversion factor, which is 1 divided by 1 plus the amount of the foreign exchange premium stated in decimal terms. In this case, the result is a factor of 0.909 (1 - 1.1 = 0.909). To obtain the economic values, we would then multiply all financial prices for non-traded items by this factor if these market prices have been judged good estimates of opportunity cost or good estimates of economic value on grounds of willingness to pay. For nontraded items such as wage rates for unskilled labor for which it is felt that the market price has overstated the economic values, we would first determine a good estimate of the economic value in domestic currency and then multiply that by the standard conversion factor. Financial prices for traded items, whether imports or exports, would be left unchanged in the economic accounts except that any transfer payment included in these prices would be taken out. To get all values into the same currency, we would convert all foreign currency prices to domestic currency values using the official exchange rate.

When we turn to determining measures of project worth in chapter 9, we will find that the absolute value of the net present worth differs depending on which approach we use, shadow exchange rate or conversion factor, but that the relative net present worths of different projects analyzed by the same approach will not change. Whichever approach is used, the internal rate of return, the benefit-cost ratio, and the net benefit-investment ratio do not change. (Using a number of disaggregated conversion factors, rather than a standard conversion factor, can give different values for the measures of project worth. Hence, for projects at the margin of acceptability, using specific conversion factors rather than a standard conversion factor or a shadow exchange rate may result in a different decision on whether to accept or reject, but such cases are infrequent.)

Adjusting Financial Prices to Economic Values

Let us now proceed with the adjustments necessary to convert financial prices to economic values. We will divide these into three steps: (1)

adjustment for direct transfer payments, (2) adjustment for price distortions in traded items, and (3) adjustment for price distortions in non-traded items. We will then note that, for what are termed "indirectly traded" items (locally produced items that use a high proportion of traded inputs, such as locally assembled tractors, or construction that uses imported materials), steps 2 and 3 must be done at the same time.

Step 1. Adjustment for direct transfer payments

The first step in adjusting financial prices to economic values is to eliminate direct transfer payments.

Direct transfer payments (see chapter 2) are payments that represent not the use of real resources but only the transfer of claims to real resources from one person in the society to another. In agricultural projects, the most common transfer payments are taxes, direct subsidies, and credit transactions that include loans, receipts, repayment of principal, and interest payments. Two credit transactions that might escape notice are accounts payable and accounts receivable. All these entries should be taken out before the financial accounts are adjusted to reflect economic values.

Many important subsidies in agriculture operate not by means of direct payments but through mechanisms that change market prices. These subsidies are not direct subsidies treated as direct transfer payments but rather are indirect subsidies. The financial price of an item for which the price has been changed because of an indirect subsidy is converted to an economic value according to the procedures outlined below for traded items in step 2 and, as appropriate, for nontraded items in step 3.

Step 2. Adjustment for price distortions in traded items

The second step in adjusting financial prices to economic values is the adjustment for distortions in market prices of traded items.

Traded items are those for which, if exports,f.o.b. price > domestic cost of production, or the items may be exported through government intervention by use of export subsidies and the like, and, if imports,domestic cost of production > c.i.f. price.

Conceptually-and usually in practice, too-prices for traded items in project analysis are more easily dealt with than those for nontraded items. We begin the valuation by determining the "border price." For imports, this normally will be the c.i.f. price and, for exports, normally the f.o.b. price. The border price is then adjusted to allow for domestic transport and marketing costs between the point of import or export and the project site; the result is the efficiency price to be used in the project account (see the subsection on "Economic export and import parity values," below).

If the proposed project produces something that can be used in place of imported goods-that is, if it produces an "import substitute"-the value to the society is the foreign exchange saved by using the domestic product valued at the border price, in this case the c.i.f. price. But if the project uses items that might otherwise have been exported-that is, if it uses "diverted exports"-then the opportunity cost to the society of these items is the foreign exchange lost on the exports forgone valued at the border price, this time the f.o.b. price.

If we are using conversion factors to allow for the foreign exchange premium, the economic value of a traded item would be obtained by converting the foreign exchange price to its domestic currency equivalent using the official exchange rate.

If we are using the shadow exchange rate to allow for the foreign exchange premium, the economic value of a traded item would be obtained by converting the foreign exchange price to its domestic currency equivalent using the shadow exchange rate.

To illustrate how these computations are made, we may take as an example an imported item such as a combine harvester for which the c.i.f. price is US$45,000. In the financial accounts, we will convert this price to domestic currency using the official exchange rate of, say, Rs10 = US$1, obtaining a c.i.f. price in domestic currency of Rs450,000 (45,000 x 10 = 450,000). To this would be added any import duty, say 10 percent, or Rs45,000 (450,000 x 0.10 = 45,000); the price of the combine in our financial accounts would therefore be Rs495,000 (450,000 + 45,000 = 495,000). (The costs of moving the harvester to the project site would also be added; see the subsection on "Economic export and import parity values," below.) If we are using the conversion factor approach to allow for the foreign exchange premium in our economic accounts, we would enter the combine in the accounts at the c.i.f. price expressed in domestic currency converted at the official exchange rate, or Rs450,000 (45,000 x 10 = 450,000). There would be no allowance for the duty because that is a transfer payment. If we are using the shadow exchange rate approach to allow for the foreign exchange premium, however, we would increase the price of the imported items to reflect the premium. Suppose we assume the foreign exchange premium to be 20 percent; our shadow exchange rate thus becomes Rs12 = US$1 (10 x 1.2 = 12). Now the Rs495,000 item in our financial accounts becomes Rs540,000 in our economic account (45,000 x 12 = 540,000). We could have accomplished the same thing, of course, by multiplying our domestic financial price (net of transfer payments) by 1 plus the foreign exchange premium (450,000 x 1.2 = 540,000). The effect of our computation, obviously, is to make imported items more expensive in our economic analysis.

The same logic works in reverse for exports. The ton of wheat that is worth $176 a ton f.o.b. at the port of export will be entered in the financial accounts by converting the foreign exchange price to its domestic currency equivalent using the official exchange rate. This gives a value of Rsl,760 (176 x 10 = 1,760), assuming that there is no export subsidy. The same rupee value would be entered in the economic accounts if we are using the conversion factor approach to allow for the foreign exchange premium. If we are using the shadow exchange rate approach to allow for the foreign exchange premium, we multiply the foreign exchange border price of the wheat by the shadow exchange rate instead of the official exchange rate to calculate the economic value expressed in domestic currency. This increases the relative value of the wheat, which now will be valued at Rs2,112 (176 x 12 = 2,112). We could have accomplished the same thing, of course, by multiplying our financial domestic price by 1 plus the foreign exchange premium stated in decimal terms (1,760 x 1.2 = 2,112). Now the ton of wheat, like other exported goods, is valued at its opportunity cost and is seen to be relatively much more valuable.

Diverted exports and import substitutes are valued by the same line of reasoning, except that for a diverted export we would take the f.o.b. price as the basis for valuation and for import substitutes we would take the c.i.f. price. In the examples of the previous paragraphs, if the country exported combines but diverted them to a domestic project, the opportunity cost would be based on the f.o.b. price instead of the c.i.f. price we assumed for imported combines. Similarly, if the wheat produced were to substitute for imports, we would base its value on the c.i.f. price of wheat rather than on the f.o.b. price we assumed for the case of exports.

In practice, values for most traded items are determined by taking the border price as we have been using it and then either subtracting or adding the domestic handling costs to obtain an economic value at the farm gate or project boundary-the economic export or import parity value (see the subsection on "Economic export and import parity values," below). Also, many items that are locally produced incorporate a significant proportion of imported components and may be considered indirectly imported items (see the section on "Indirectly Traded Items," below). To determine either parity values or values for indirectly traded items involves valuing separately not only the traded component but the nontraded component as well, so we will defer detailed discussion of these values until we have discussed valuing nontraded items.

Step 3. Adjustment for price distortions in nontraded items

The third step in adjusting financial prices to economic values is the adjustment for distortions in market prices of nontraded items. Nontraded items are those for which c.i.f. price > domestic cost of production > f.o.b. price, or the items are nontraded because of government intervention by means of import bans, quotas, and the like.

Often, nontraded items will be bulky goods such as straw or bricks, which by their very nature tend to be cheaper to produce domestically than to import but for which the export price is lower than the domestic cost of production. In other instances, nontraded items are highly perishable goods such as fresh vegetables or fluid milk for direct consumption.

In general, these are produced under relatively competitive conditions-they are produced either by many small farmers or by a few industrial producers for whom entry into the market is relatively easy; thus prices cannot rise too far out of line before new competition appears.

If we are using the shadow exchange rate approach to allow for the foreign exchange premium, and if the market price of a nontraded item is a good estimate of the opportunity cost, or willingness to pay is the criterion, we will accept the market price directly as our economic value. Otherwise, we will adjust the market price to eliminate distortions by the methods outlined in this section and then use the estimate of the opportunity cost we obtain as the shadow price to be entered in the economic accounts.

If we are using the conversion factor approach to allow for the foreign exchange premium, an additional step is necessary. All prices for non-traded items are reduced by multiplying them by the appropriate conversion factor. When willingness to pay is the criterion or when the market price is considered to be a good estimate of opportunity cost, the market price is accepted as the basis for valuation and then reduced by multiplying it by the conversion factor to obtain the economic value. But if we are using the standard conversion factor and the market price must be adjusted to obtain a better estimate of the opportunity cost, then the opportunity cost must, in turn, be multiplied by the standard conversion factor. (If specific conversion factors have been developed, as Little and Mirrlees and Squire and van der Tak suggest in their systems, then these factors incorporate the adjustments for nontraded goods distortions, opportunity costs, and distribution weights; the market price need only be multiplied by the specific conversion factor to reach the economic value.) Whether we use a shadow exchange rate or a standard conversion factor to allow for the foreign exchange premium, the adjustments we make to allow for distortions in market prices of nontraded items are essentially the same; only the step of multiplying the market price or the opportunity cost by the standard conversion factor differs.

As we said earlier in the chapter, prices for traded items are more easily adjusted to economic values than are prices for nontraded items. The following subsections treat some of the difficulties encountered in determining economic values for various nontraded items.

Market prices as estimates of economic value.. In a perfectly competitive market, the opportunity cost of an item would be its price, and this price would also be equal to the marginal value product of the item (see chapter 3). If a nontraded item is bought and sold in a relatively competitive market, the market price is the measure of the willingness to pay and is generally the best estimate of an opportunity cost. Most agricultural projects are expected to meet a growing demand for food or fiber and are small relative to the total agricultural production of the nation. If that is the case, in general we can accept the market price directly as our estimate of the economic value of a nontraded item. Also, if we are valuing a domestically produced project input that is produced by a supply industry operating near full capacity, we can generally accept the market price of the input as its economic value.

In some instances more common in industrial and transport projects than in agricultural, the output of the project is large relative to the market. The output from the project may therefore cause the price to fall. But the economic value of the new production, despite the fall in price, is not lower to the old users of the product; to them, it is still worth what the price was without the project. Yet to *new* users, the project output is not worth what the old price was; otherwise, the price would not have fallen. Under these circumstances, the economic value of the new output is neither the old price nor the new; rather, it is estimated by some weighted average of the old and new values. In technical economic terms, the total value of the new output is measured by the additional area under the demand curve as project output is increased, and the marginal value in use for each new buyer is measured by the demand curve at the point the buyer enters the market. The problem is that the precise shape of the demand curve is rarely known. As a result most project economists, when dealing with a project whose output is large relative to the market, adopt a simplifying rule of thumb-they assume that the demand curve is linear and downward sloping at 45 degrees. They then take the new estimate of the average value in use or opportunity cost-hence, of economic value-to be the average of the price without the project and the lower price with the project.

Sometimes a project will be proposed that does not meet new demand but replaces other goods or services in the market. Again, this is more common in industrial and transport projects than it is in agricultural. In such situations, if the project accounts are cast on a with-and-without basis, the economic value of the incremental net benefit stream would reflect only the saving from the new project compared with the old. This is because one of the costs of the new project would be the benefit forgone from the old production no longer realized and because one of the benefits would be the cost avoided for the old production. Such a case might arise, for instance, if an inefficient food processing plant were to be replaced by a more modern and efficient one, or if a high-cost railway branch line were to be replaced by bus and truck transport along an existing highway. Occasionally, however, a project will be proposed for a new plant that will replace existing output, and the analyst fails to recognize the with-and-without situation. Instead, he values the output from the new plant as if it were meeting new demand and forgets to charge as a cost to the project the benefit forgone from the production of the old plant that is to be displaced. If the project is not to be cast on a with-and-without basis, then the analyst must take as his gross benefit only the economic value of the resources saved by replacing the old plant, not the economic value of the output from the new plant.

Note that some nontraded items may involve using significant amounts of imported raw materials. These will be considered below, in the discussion of indirectly traded items. Such items might include machinery assembled domestically from imported components or electricity that is generally nontraded but that may require imported generating equipment and traded fuels for production.

One nontraded item that can sometimes lead to confusion is insurance. At first glance, insurance might look like a transfer payment and thus would not be included in the economic accounts of the project. We may, however, look upon insurance as a kind of sharing of the risk of real economic loss. This would be the case for fire insurance if project buildings were to be pooled with many other buildings in the society. In the event of a fire, there is a real economic cost. The resources used to replace a burned building, or the output forgone because a building no longer is available, reduce the amount of final goods and services available to the society and thus create a real reduction of the national income. Therefore, to the extent an insurance cost represents sharing of risk, it represents a proportionate sharing of real economic cost and should be included in the economic accounts. The insurance rate is usually based on the probability of a real loss and the value of the item insured.

Although the market price can frequently be accepted as a good estimate of the economic value of a nontraded item, for institutional reasons of one kind or another the market price can vary significantly from the opportunity cost of the item to the society. Two such nontraded items are important in most agricultural projects: land and labor.

Valuing Land. The opportunity cost of land is the net value of production forgone when the use of the land is changed from its without-project use to its with-project use.

The simplest case to value is one in which land changes use but not management control, either because an owner-operator is farming the land or because the same tenant continues to farm it. This is a common case in agricultural projects in which farmers are simply encouraged to adopt a more productive technology. If the analyst has laid out the financial accounts to show the situations with and without the project for farm budgets as suggested in chapter 4, then the incremental net benefit (that is, the incremental cash flow) of the project, when financial prices have been converted to economic values and the accounts aggregated as suggested in chapter 8, will include an allowance for the net value of production forgone by changing the land use. Take, for example, the Kemubu Irrigation Project in Malaysia in which new irrigation water permitted changing the land use in the dry season from rather unproductive pasture to second-crop paddy rice production. The contribution of the land to the value of the pasture-hence, its opportunity cost-would be properly accounted for when the value of the weight gain of the livestock pastured on the land without the project is subtracted from the value of the paddy rice produced on the land with the project. Converting project financial prices to economic values-say, changing the market price of the weight gain of the animals on the pasture and the market price of paddy rice to their economic equivalents if these are seen to be different from the market prices-automatically revalues the opportunity cost of the change in land use from financial to economic terms.

In other instances, however, the financial accounts must show a cost for purchasing land or the right to use it. Here problems arise because in many countries agricultural land is hardly sold at all, and, when it is, considerations of investment security and prestige may push its price well above what the land could reasonably be expected to contribute to agricultural production. In these instances, we will not want to accept the market purchase price as a good estimate of the economic opportunity cost of the land and must search for an alternative. Many times that alternative will be to take the rental value of the land. In a number of countries, although land is infrequently sold, there is a fairly widespread and competitive rental market. This may be true if there is considerable tenancy in the country, of course, but it may also hold true if the dominant form of land tenure is the owner-occupied farm. Older farmers may not wish to cultivate all of their holdings themselves and will be willing to rent a field to a younger neighboring farmer; widows may not wish to operate their holdings themselves; or a farmer suffering from an illness may wish to rent part of his farm for a season while he recovers. When such a rental market exists, it probably provides a fairly good indication of the net value of production of the land and, hence, of the opportunity cost if the land use is changed. A renter is not likely to pay any premium for prestige or investment security and thus will not pay a rent higher than the contribution the land can make to the crop he proposes to grow. That rental value may then be entered in the project's financial account year by year as a cost. Alternatively, it may be capitalized by dividing the rent by an appropriate rate of interest stated in decimal terms; the capitalized value is then entered in the first year of the project's financial accounts. The appropriate rate of interest actually would be the economic rate of return (see chapter 9), but this may well involve repetitive computations. Some analysts prefer to use the opportunity cost of capital (also discussed in chapter 9). If this rate were, say, 12 percent and the going rental rate were Rs525 a hectare, then the capital value of a hectare would be Rs4,375 (525 - 0.12 = 4,375). If we were using the conversion factor approach to allow for the foreign exchange premium, this capitalized value would be, in turn, multiplied by a conversion factor. If the standard conversion factor were 0.909, for instance, the land would then have an economic value of Rs3,977 (4,375 x 0.909 = 3,977). At the end of the project, the same value of the land could be credited to the project as a residual value.

Inevitably, however, there will be instances in which neither the purchase price nor the rental value is a good estimate; we then will have to make a direct estimate of the productive capability of the land. Such a direct estimate is not difficult if idle land is to be used for a settlement project. In the projects financed by the World Bank in the Amazon basin at Alto Bene in Brazil and in the Caqueta region of Colombia, the land without the project would in effect have produced no economically valuable output at all. Hence, the net value of production forgone was clearly zero, and no value for the land was entered in the project economic accounts. If settlers were required to pay the government a purchase price, either all at once or in installments, the farm budgets at market prices in the financial analysis would have to show those payments as a cost. When these financial farm budgets were converted to economic values, however, there would be no cost entered for the land because there was no reduction in national income as a result of shifting its use from jungle to farmland. (Of course, the cost of clearing jungle land should be reflected somewhere in the project costs.)

In other cases it will not be so simple. The analyst will have to make a direct estimate of the net value of production forgone for bringing the land into the project. A straightforward approach is to take the gross value of the land's output at market prices and deduct from that all the costs of production-including allowances for hired and family labor and for the interest on the capital engaged, again all at market prices. The analyst can assign the residual as the contribution of the land to the production of the output and take that as the opportunity cost of the land in financial terms. This set of computations can then be converted to economic terms by using economic values for each of the input and output entries. For those familiar with the technique, estimating a production function would provide a much more accurate estimate of the contribution of the land to the value of the output than the direct method described here and thus is a preferable approach.

Valuing Labor. Wage rates for labor in many developing countries may not accurately reflect the opportunity cost of shifting labor from its without-project occupation to its with-project use.

The price of labor in a perfectly competitive market, like other prices in that impossible place, would be determined by its marginal value product. That is, the wage would be equal to the value of the additional product that one additional laborer could produce. It would pay a farmer to hire an additional laborer-for harvesting, for example-so long as that extra worker increased total output by a value more than the wage the farmer had to pay him.

Even in labor-abundant societies, there are probably peak seasons at planting and harvesting when most rural workers can find employment. At those seasons, the market wage paid rural labor is probably a pretty good estimate of its opportunity cost and its marginal value product; therefore, we could accept the market wage as the economic value of the rural labor.

The problem of course is that, except for the peak seasons, in many crowded countries the addition of one more laborer may add very little to the total production-in an extreme instance, nothing at all. That is, if there is a surplus of agricultural workers, there may be very little or virtually no productive outlet for their energies in the off-season. In technical language, we may say that the marginal value product of such labor-the amount such labor adds to the national income-is very close to zero. Because the marginal value product of labor is also the opportunity cost of labor in the economic accounts, we may make another statement: if we take a laborer away from a farm community where he is

producing very little or nothing and put him to work productively in an agricultural project that produces something of value, we do not have to forgo very much to use this labor to realize new production. This being the case, we can consider the cost of the laborer to be very low-some economists would say even zero. By this line of reasoning, the proper value to enter in the economic (not financial) account as the cost of labor would be very small, perhaps only a fraction of the going market wage. If the opportunity cost of labor in an agricultural project is properly priced at a very small amount, then it is likely that the rate of return on the project will look very favorable in comparison, say, with a capital-intensive alternative project that uses labor-saving tractors or expensive imported harvesting machinery.

Note that the validity of this reasoning is not changed by the fact that agricultural labor is, in fact, paid a wage well above its opportunity cost. A common example of a "wage" paid, even though little productive work is available on the margin, is found in the case of family labor. Older children and the farmer's wife will be entitled to a share of the family income even if the family farm is too small to give them an opportunity to be productive. In this instance, if an older son were to find productive employment elsewhere, the total production on the farm might be reduced by very little or none at all. Yet, because the older son is entitled to a share of the total family income, he would accept new employment far away from his home only if he were offered a wage in excess of his share-and that might be well above what his marginal value product would be and the reduction in farm output that would occur if he were to leave.

Rural wages may be above the marginal value product because of a traditional concept of a "proper" wage or because of social pressure on the more prosperous farmers in a community to share their wealth with their less fortunate neighbors. In parts of Java, for example, social custom prevents even quite small farmers from harvesting their own rice. Instead, they permit landless laborers to do the work, even though the farmer himself may well have the time to do it. This is explicitly seen by the community as a means of providing at least something for the poorest agricultural laborers. Unfortunately, increasing economic pressures on small farmers and continued population growth are leading to a break-down of this system.

Virtually all economists now agree that the marginal value product of agricultural labor on an annual basis worldwide is more than zero, so that in every instance our opportunity cost of labor, at least in some season or another, will be positive-even though it may still be very low. [A more detailed discussion of the marginal value product of agricultural labor can be found in McDiarmid (1977) and in Barnum and Squire (1979).]

To begin our discussion of how actually to determine an economic value for labor, we can take the easiest case. In most instances, skilled labor in developing countries is considered to be in rather short supply and would most likely be fully employed even without the project being considered. Hence, the wages paid workers such as mechanics, foremen, or project managers are in general assumed to represent the true marginal value product of these workers, and the wages are entered at their market values in the economic accounts. The rationale here is that, if those skills are in such scarce supply that they would be worth more than the going wage, then someone in the society would be prepared to pay more, and the skilled worker would then move to where he could earn that higher wage, thus establishing a new equilibrium. This convention of accepting market wages as good estimates of economic value may substantially undervalue skilled labor or the management skills of such top civil servants as extension specialists and project managers-or project analysts!

Note too that, as we consider the opportunity cost of labor and how to estimate it, if we set the financial accounts so they correctly show the situations with and without the project, then the opportunity cost of family labor will be appropriately priced in financial terms. Suppose that, in the dry season without the project, a farmer along the north coast of Java could find essentially no gainful employment. With the advent of the Jatiluhur Irrigation Project he now is able to produce a second crop of rice, and his net benefit rises accordingly. When we subtract his without-project net benefit (which would be essentially only what the family could earn for a rainy-season rice crop) from the with-project net benefit (which will include earnings from two crops), the incremental net benefit will correctly show the labor return the family had to give up during the dry season (essentially nothing) to participate in the project and produce a second crop of rice. Shifting the financial prices in the farm budget to economic values also automatically converts the opportunity cost of family labor to economic values.

To make our farm budgets work this way, we must remember to include any off-farm earnings in the accounts. Suppose we assume that the farmer from the north coast of Java goes to Jakarta and finds employment in the construction industry during the dry season, as many such farmers do. The without-project net benefit will thus be increased by the amount of the farmer's off-farm earnings. If he wishes to use Jatiluhur irrigation water to produce a second crop of rice, he must now give up the construction wages he could otherwise have earned in the dry season. In turn, when we subtract the without-project net benefit from the with-project net benefit, which includes the returns from two crops of rice, the incremental net benefit will be smaller by the amount of the opportunity cost of labor at the market wage, that is, by the amount of construction earnings the farmer must forgo. We may proceed to convert these financial accounts to economic terms by revaluing the appropriate entries at their shadow prices. In doing so, however, we must remember that one shadow price will be the shadow wage rate for the construction earnings the farmer had to forgo. It is to estimating this shadow wage rate that we now may turn.

In most discussions of the marginal value product of labor-hence, of its economic opportunity cost-the standard is the productivity of the marginal agricultural laborer. This is true not only for agricultural projects but also for projects in other sectors, since it is assumed that additional manufacturing employment, for example, will tend to reduce the number of unemployed agricultural laborers. This would be true even if it is urban workers drawn from some other urban occupation who actually take the new factory jobs, since it is assumed the jobs they vacate will, in turn, be filled by workers drawn from agriculture.

Cast in this form, our estimate of the shadow wage rate must now focus on how to estimate the marginal value product of agricultural labor without the project. We can begin by noting that in most agricultural communities there is usually a season when virtually everyone who wants work can find it. Even unemployed urban laborers may return to their home villages in these peak seasons to help their families or to work as hired laborers. This happens at harvest time in Java, and may happen at the peak planting time in other areas where transplanted rice is grown. Thus, we may reasonably assume that this peak season labor market is a relatively competitive one, that labor is in relatively short supply at this period, and that the daily wage at this period is a good indicator of the daily marginal value product of the labor engaged.

With this accepted, a good estimate of the annual shadow wage for agricultural labor is the number of days in the year when most rural labor can expect to find employment, multiplied by the daily wage rate at such times, and reduced by a conversion factor if appropriate. If an agricultural worker's daily wage at harvest were Rs7.50, and during harvest and other peak seasons most people in the rural work force could find employment for 90 days, then his annual shadow wage might be Rs675 if we are using the shadow exchange rate approach to allow for the foreign exchange premium (7.50 x 90 = 675), or Rs614 if we are using the conversion factor approach and the factor is 0.909 (7.50 x 90 x 0.909 = 614). Now if we wanted to hire an agricultural laborer to work in our project for 250 days a year, all the society would give up in production-the opportunity cost-would be Rs675 if we are using the shadow exchange rate approach, or Rs614 if we are using the conversion factor approach. This opportunity cost is the economic value of the annual earnings of the laborer without the project. Note that we surely would have to expect to pay a wage much greater than this amount, and thus our financial accounts at market prices would have quite a different cost for this same agricultural laborer. It is possible, for instance, that the hired laborer would expect a wage of Rs7.50 a day for all 250 days he worked during the year, or an annual wage of Rs1,875 (7.50 x 250 = 1,875). More probably, he would be willing to work for rather less a day outside the harvest season-say, Rs5.00 a day. Thus, his annual wage might be something more on the order of Rs675 for 90 days and Rs5.00 a day for the remaining 160 days, or an annual total wage of Rs 1,475 [(7.50 x 90) + (5.00 x 160) = 1,475]. The project analyst would clearly have to form a judgment of the shadow wage of hired labor on the best basis he could, just as he must for every other price estimate he makes.

Of course, in many agricultural projects labor is not engaged on a year-round basis. Rather, the work is quite seasonal, and we must consider in which particular season hired labor would be engaged. If our new cropping pattern calls for work to be done during the peak season, then we will have to consider that the peak season market wage is probably a good estimate of the marginal value product, and we could not justify using a lower wage as the basis for our shadow wage rate, even though there might be considerable unemployment in the off-season. In Egypt, for example, a common rotation calls for both rice and cotton to be harvested in October. If we were to propose a project incorporating these crops-or another crop requiring hired labor at this period-then the going wage (in 1975 about E^0.30 a day; the symbol for Egyptian pounds is E^) would be paid. Since even in a country as populous as Egypt most rural labor can find employment at this peak season, the use of a shadow wage rate derived from a basis less than the market wage would be unjustified. But suppose our project called for growing maize, which is planted in May when there is little other agricultural work available and harvested in August before the peak harvest season for rice and cotton. Then we might find that, on the margin, many agricultural laborers were either unemployed or not very productively engaged at that season and that to draw them into maize planting might entail an opportunity cost considerably less than the going wage, although it would perhaps not be zero. Thus, we might estimate that at this season the combination of being able to work only two or three days a week on the average, and then at jobs of rather low productivity, would justify taking a shadow wage rate based on half the going market rate. This would mean the equivalent of E^0.15 in 1975 if we are using the shadow foreign exchange rate approach (0.30 - 2 = 0.15), or E^0.14 if we are using the conversion factor approach and the conversion factor is 0.909 (0.30 - 2 x 0.909 = 0.14), even though our farm budget at market prices would continue to show a wage for hired labor of E^0.30.

All of these considerations will have to be adapted to fit the circumstances of any given project. For example, in India nationwide we might expect a shadow wage rate for agricultural labor rather less than the going wage rate. But using a nationwide shadow wage rate in particular projects might underestimate the true opportunity cost of the labor actually engaged in a project. The peak season in the Punjab, for instance, finds virtually all agricultural labor fully engaged, but in the neighboring state of Haryana the marginal labor in agriculture is not fully engaged. While many laborers from Haryana do migrate in search of peak season employment in the Punjab, not enough do so to meet the demand for labor completely. Using a very low shadow wage rate for a project in the Punjab might be unjustified because at the peak season the project would have to bid labor away from harvesting. Thus, although the shadow wage rate might not be as high as the harvest wage (but it might), neither would it be as low as conditions in neighboring Haryana might otherwise indicate.

This discussion of how to value labor applies whether labor is to be paid a money wage or is to be compensated in kind. The discussion so far has emphasized that it is the opportunity cost that determines the value of labor in the system of economic analysis we have adopted. The value of

the payment actually made to labor-whether in money or in kind-is not the issue. If we shadow-price labor, we already are acknowledging that the wage the labor receives is different from the benefit forgone by using that labor in the project instead of in its next best alternative use without the project. It is the opportunity cost of the labor, not the form of payment, that sets the economic value of labor. Hence, it is irrelevant in a determination of the economic value of labor whether labor is paid a money wage or is compensated in kind-for example, in food grain, even though the food grain may be a tradable commodity and even though the food grain itself might need to be shadow-priced if it is to be valued.

*Excess Capacity***.** In some projects, a domestically produced input may come from a plant that is not operating at its full capacity. If that is the case, then the opportunity cost of using the input in a new project is only the marginal variable cost of producing the input, and no allowance need be made for the fixed capital cost of the plant itself. If the national cement industry is operating at less than its full capacity and it is proposed to line irrigation canals with cement, then the cost of the cement for the canals would be only the marginal variable cost of producing the cement. This would be less than the average cost of cement production, which would include some allowance for fixed costs of production.

Situations such as these are more common in industrial projects than in agricultural projects. When they do occur, however, they may influence the timing of projects. A canal-lining project might be quite attractive if it is begun soon, while there is excess cement-manufacturing capacity, but much less attractive later, when demand has caught up with the cement industry's capacity. To supply cement for canal lining later, after demand has picked up, would entail constructing an additional cement plant. At that time, new fixed as well as variable costs would be incurred, and the analyst would include all costs, both fixed and variable, plus an estimate of the "normal" profit in calculating the cost of cement.

TRADABLE BUT NONTRADED ITEMS. In the system of project analysis presented here, we lay out the economic accounts as best we can to reflect the real resource costs and benefits of the proposed project. The project will be carried out within a framework of economic policies set by the government. The project analyst must make the best judgment about what those policies are and will be, not just what they ought to be, and work the economic analysis accordingly. This can lead to difficult choices when the analyst must evaluate the real effects on resources of a project that involves items that could be traded but probably will not be because of government regulation. These items, which are "tradable but non-traded" across national boundaries, are valued as nontraded.

Such items would usually be imported were it not for an import quota.oo or an outright ban that is enforced against them. Their domestic price may well rise high above the prevailing price on the world market. The import restriction might be enforced to protect domestic industries, even

though the imported item may be preferred by consumers. Import of foreign engines for tubewells, for example, may be forbidden so that domestic manufacture might be encouraged. Yet, the domestic equivalent may not be as efficient or as durable as the imported engine and may cost more to produce. The domestic engine clearly could not compete on the world market, and it would therefore be a nontraded item. For those few imported engines allowed to enter the country, the price may rise quite high. This indicates that to some buyer the imported item is worth more than its domestic equivalent. If our project will use one of these engines, the economic value is *not* a price based on the world market as if the engines could be relatively freely traded. Rather, it is the higher domestic market price of the imported engine, which indicates its high opportunity cost. Upon reexamination, of course, we might consider changing the project design to use the domestic engine-for example, we might do so if we find the domestic engine to be less costly when valued at shadow prices.

For the domestic equivalent of an imported item, the market price usually will closely approximate the real resource use that went into producing it. But if there is a shortage and the price is bid up, in the absence of additional imports the market price will rise above the cost of production. In this case, the opportunity cost of the item will not be determined by the resources used to produce it but by its marginal value product in its best alternative use. If the price is higher than is justified by the resources used to produce the item, it may well be because to *someone* that high price for the domestic engine is worth it-for this buyer's purposes, the marginal value product of the scarce engine at least equals the market price. If we wish to bid that engine away for use in our project, we are denying its use to the other potential buyer. If we use the engine in our project, the economy must forgo the productive contribution of the engine in the alternative use the other potential buyer had in mind-our standard concept of opportunity cost. Again, in this instance the opportunity cost is most likely well estimated by the market price; if it were not, other buyers would not have bid the price up so high for the limited number of engines available.

If there is an import ban on an imported final good or service, then we will base the economic valuation on the criterion of willingness to pay and accept the market price as a good indicator of the economic value of the product-provided that we expect the trade ban to remain in force throughout the life of the project. Earlier we cited the example of a ban on sugar imports that would force the domestic price of sugar above its border price. If the ban on imports will continue, then the higher price of sugar indicates a willingness to pay that, in turn, is an indicator of the economic value set on sugar by the consumers. In the project analysis, we would accept this market price as the economic value, not a border price as if the sugar were being traded.

For both kinds of import substitutes we have cited, the analyst may want to prepare an analysis that will indicate the effect on the proposed project of lifting the import ban. We will discuss this topic further below,

and value each separately. Take locally assembled tractors, for example. We may be told that the market price of Rs65,000 includes a 30 percent local component (in other words, 30 percent of the market price represents domestic value added) and that 70 percent of the market price represents the imported component, which includes a 15 percent tariff. Thus, the local component will amount to Rs19,500 (65,000 x 0.3 = 19,500), and the imported component including the tariff will amount to Rs45,500 (65,000 x 0.7 = 45,500). The domestic value added will most likely arise from sources such as wages paid domestic skilled labor and domestically manufactured items that use mainly domestic raw materials. If so, we probably can accept the market price as a good indicator of the opportunity cost to the economy of these items.

To determine the economic value of the imported component of the tractor, the tariff must first be eliminated. This may be done by dividing the value of the imported component including the tariff by 1 plus the percentage of the tariff stated in decimal terms; this calculation gives a value for the imported component without the tariff of Rs39,565 (45,500

1.15 = 39,565). This is, of course, the c.i.f. price converted to its domestic equivalent at the official exchange rate.

Now, if we are using the shadow exchange rate to allow for the foreign exchange premium, we will want to revalue the imported component of the indirect import (after the tariff has been eliminated) to reflect the distortion in the prices of traded goods. To do this, we can take the c.i.f. price converted at the official exchange rate and multiply it by 1 plus the foreign exchange premium stated in decimal terms. If the official exchange rate is Rs10 = US$1 and the foreign exchange premium is 20 percent, then for the imported component of the tractor we derive a value of Rs47,478 (39,565 x 1.2 = 47,478). (We could, of course, have taken the c.i.f. price in foreign exchange and converted it to its domestic equivalent by the shadow exchange rate; this would have given the identical result.) The shadow price of the tractor is now the market price of the domestic component, which we calculated to be Rs19,500, plus the shadow-priced value of the imported component of Rs47,478-or a total economic value of Rs66,978 (19,500 + 47,478 = 66,978).

If we are using the conversion factor to allow for the foreign exchange premium, the economic value of the imported component will be the c.i.f. price converted to the domestic currency equivalent at the official exchange rate after eliminating the tariff, or Rs39,565. To obtain the economic value of the domestic component we will need to multiply it by the conversion factor. For efficiency prices, we would use the standard conversion factor of 1 divided by 1 plus the foreign exchange premium stated in decimal terms. In this instance, the foreign exchange premium is 20 percent, so the standard conversion factor becomes 0.833 (1 - 1.2 = 0.833). Applying this to the domestic component of the tractor, estimated to be Rs19,500 at market prices, gives us an economic value of Rs16,244 (19,500 x 0.833 = 16,244). The shadow price of the tractor now becomes the sum of the imported component valued at c.i.f. converted at the

official exchange rate and the shadow price for the domestic component, or Rs55,809 (39,565 + 16,244) = 55,809).

In some agricultural projects, electricity is an important cost that may raise valuation problems. Electricity is usually thought of as a nontraded commodity. In reality, part of the value of electricity in most developing countries arises from the imported generating and transmission equipment and, perhaps, from imported fuel. Thus, in our system of project analysis, electricity might be an indirectly traded item. The first difficulty is that the price charged for electricity is not competitively set, since there is no competition in electricity. Rather, electricity rates are administered prices, and electricity prices thus may bear little relation to marginal value product or to opportunity cost. No easy means exists to resolve this problem. Some average rate, or perhaps some weighted average rate, will probably have to suffice as an estimate of opportunity cost at market prices. Once a rate is accepted, an estimate will have to be made of the domestic and imported components, and the components revalued using the shadow exchange rate or a conversion factor as appropriate, just as for any other indirectly imported item (and as we illustrated earlier by the example of tractors assembled from imported components). These calculations would usually not be undertaken by agricultural project analysts. The planning office should estimate a shadow price for electricity and other utilities to be used in all project analyses.

For some agricultural projects, new generating facilities will be required. In the simplest case, we might think of a project remote from the electric grid, such as a settlement project, in which a diesel generating unit might be included as a cost of the project. In that instance, there would be no particular problem of valuation. When new generating facilities would be needed to meet the demand on the power grid arising from an irrigation project, however, the problem would not be so simple. Here, the best approach would probably be to ask the electricity authority for an estimate of the additional cost the authority would incur for this particular project, and then to treat that cost-properly shadow-priced to allow for the imported component-as the opportunity cost. The cost of the additional facilities needed for the project will probably have to be reduced to a kilowatt-hour basis (using, perhaps, the capital recovery factor to estimate the annual charge for the new facilities).

We have contrasted use of a shadow exchange rate and a conversion factor to correct for price distortions caused by import and export tariffs and subsidies, and we have noted that the same correction can be realized whichever approach is used. This is illustrated in table 7-1, in which an economic account for a hypothetical project is drawn up using both a shadow exchange rate and a standard conversion factor.

When indirectly traded items will be used repeatedly in projects, it may be convenient to have specific conversion factors that, once they are derived, can be directly applied to the same class of indirectly traded items. This is the approach both Little and Mirrlees (1974) and Squire

Table 7-1. Use of Shadow Exchange Rate and Standard Conversion Factor Compared

Economic value (Rs)[b]

Item	Rs	Financial	values US $		Using shadow exchange rate`		Using standard-conversion factor	d	*Remarks*
Inflow									
Gross value of wheat									Traded item
produced	1,750		175		2,100		1,750		
Total	1,750		175		2,100		1,750		
Outflow									
Unskilled labor									Nontraded
(shadow wage rate									item
= 50% market wage)	600		60		300		250		
Imported fertilizer	200		20		240		200		Traded item
Tractor services									Indirectly
75% imported									traded item
component	90		9		108		90		
25% domestic		120		12		138		115	
component	30		3		30		25		

Total	920		92		678		565		
Net benefit	830		83		1,4 22		1,18 5		
Ratio of inflow to									
outflow	1.90		1. 90		3.1 0		3.10		

Rs Indian rupees. US$ U.S. dollars.

a. The official exchange rate is assumed to be Rs10 = US$1. Financial prices are converted by this official exchange rate.

b. The foreign exchange premium is assumed to be 20 percent. As in note a, the official exchange rate is assumed to be Rs10 = US$1.

c. The shadow exchange rate is the official exchange rate of Rs 10 multiplied by 1 plus the percentage of the foreign exchange premium stated in decimal terms, or Rs12 (10 x 1.2 = 12), so that Rs12 = US$ 1. Foreign exchange prices

are converted into domestic currency values by multiplying the foreign currency price by Rs12.

d. The standard conversion factor is the reciprocal of 1 plus the foreign exchange premium stated in decimal terms, or 0.833 (1 - 1.2 = 0.833). Foreign currency prices are converted into decimal currency values at the official exchange rate. Domestic currency prices are multiplied by the standard conversion factor of 0.833.

and van der Tak (1975) suggest, and both sets of authors recommend that some central agency prepare specific conversion factors for project analysts to use. It is possible in a parallel manner to derive "specific shadow exchange rates" that may then be applied repeatedly, although in practice this has rarely been done. Instead, when the shadow exchange rate approach is followed, nontraded items are decomposed into their traded and nontraded elements and each is valued separately. Use of a specific conversion factor can be illustrated by referring to table 7-1. Suppose we planned a number of projects in which tractor services would be important and we wanted a specific conversion factor for tractor services. Once we had the conversion factor in hand, we could multiply the domestic market price of items in each project by the same specific conversion factor to obtain the various economic values. In table 7-1, in the column illustrating use of the standard conversion factor, we have a value for the imported component of the tractor services of Rs90, which was converted at the official exchange rate. The domestic component was multiplied by the standard conversion factor to obtain an economic value of Rs25. If we accept this as a good estimate of the value of the domestic component, then by adding the two we reach an economic value for the tractor services of Rsl 15. If we divide this economic value by the domestic price, we obtain a specific conversion factor of 0.958 (115 - 120 = 0.958). In the future, we can simply multiply the market price of tractor services by the specific conversion factor to obtain the economic value directly.

Economic export and import parity values

The economic value of a traded item-either an export or an import-at the farm gate or project boundary is its export or import parity value. These values are derived by adjusting the c.i.f. (cost, insurance, and freight) or f.o.b. (free-on-board) prices (converted to economic values) by all the relevant charges (again converted to economic values) between the farm gate or project boundary and the point where the c.i.f. or f.o.b. price is quoted. The general method of calculating export and import parity prices was discussed in the last section of chapter 3. When these financial prices are adjusted to derive their economic equivalent, both traded and nontraded elements must be valued simultaneously.

The methods for deriving import and export parity values are parallel. Thus, it is unnecessary to discuss the method for both; instead, we will discuss only derivation of the import parity price as an example because import parity values tend to be a bit more complicated to derive.

We may return to the example of the imported combine harvester used earlier in the chapter to illustrate economic valuation of a traded item. In our financial accounts, the c.i.f. price of US$45,000 was converted to its domestic currency equivalent at the official exchange rate of Rs 10 = US$1, to which we would add, say, a 10 percent duty, Rs 1,500 in domestic handling and marketing charges, and Rs2,250 in internal transport costs to the project site-for an import parity price at the farm

gate of Rs498,750 [(45,000 x 10) + (45,000 x 10 x 0.10) + 1,500 + 2,250 = 498,750].

To obtain the economic import parity value at the farm gate or project boundary when using the shadow exchange rate to allow for the foreign exchange premium, we would make the same computations except that we would use the shadow exchange rate and omit the tariff, which is a transfer payment. In the illustration of valuing traded items, we assumed that the foreign exchange premium on the imported combine was 20 percent, and so we assumed a shadow exchange rate of Rs12 = US$1 (10 x 1.2 = 12). Now, to obtain the import parity value of the harvester, we would convert the c.i.f. price to its domestic equivalent using the shadow exchange rate, omit the tariff, and then add the value of the nontraded domestic items. To simplify matters, we will assume that all costs of moving the combine to the project site reflect only nontraded items-although that might not be acceptable if, say, the transport costs included significant amounts of petroleum fuel. We now reach an economic import parity value of Rs543,750 [(45,000 x 12) + 1,500 + 2,250 = 543,7501.

If we are using the conversion factor to allow for the foreign exchange premium, the foreign exchange would be converted to its domestic currency equivalent in the economic accounts by using the official exchange rate, and every nontraded item would be reduced by the conversion factor. Recalling that the standard conversion factor is 1 divided by 1 plus the foreign exchange premium stated in decimal terms, we obtain a standard conversion factor of 0.833 (1 - 1.2 = 0.833). Now, to obtain the economic import parity value of the harvester at the farm gate or project boundary, we convert all foreign exchange costs to domestic currency at the official exchange rate and reduce all prices of nontraded items by applying the standard conversion factor. Again, we will assume that the transport costs are predominantly made up of nontraded items. As before, we will omit the tariff because it is a transfer payment. The economic import parity price thus becomes Rs453,124 [(45,000 x 10) + (1,500 x 0.833) + (2,250 x 0.833) = 453,124].

In certain instances, the value in local currency of an imported item at the project site will be known, as will the rate of tariff and local transport charges from the point of import to the project site. If this is the case, to determine the economic value it is necessary to determine the c.i.f. price, take out the tariff, and allow for the cost of domestic transport. Using our previous values, we may know, for example, that a combine harvester delivered to the project site costs Rs498,750, that the tariff on imported harvesters is 10 percent, and that local transport and domestic handling from the point of import to the project site costs Rs3,750. We know that the official exchange rate is Rs10 = US$1 and that the foreign exchange premium is 20 percent, so the shadow exchange rate would be Rs12 = US$1 (10 x 1.2 = 12) and the standard conversion factor 0.833 (1 - 1.2 = 0.833). We deduct the cost of local transport to obtain a financial value of Rs495,000 at the point of entry, which includes the c.i.f. price plus the duty (498,750 - 3,750 = 495,000). To take out the duty, we divide by 1 plus the percentage of the duty stated in decimal terms to obtain

Rs450,000 (495,000 - 1.1 = 450,000). This is the c.i.f. value at the official exchange rate. We can then divide by the official exchange rate to obtain the c.i.f. value in foreign exchange of US$45,000 (450,000 - 10 = 45,000). If we are using the shadow exchange rate to allow for the foreign exchange premium, we can obtain our c.i.f. economic value by multiplying by the shadow exchange rate of Rs12 = US$1 to obtain a value of Rs540,000 (45,000 x 12 = 540,000). Then, to obtain the economic value at the project site, we would add the cost of transport from the point of entry to the project site; this yields an economic import parity value for the harvester at the farm gate or project boundary of Rs543,750 (540,000 + 3,750 = 543,750). If we are using the conversion factor to allow for the foreign exchange premium, the economic value of the combine at the port will be the c.i.f. foreign exchange price converted at the official exchange rate, or Rs450,000 (45,000 x 10 = 450,000). To obtain the economic import parity value at the farm gate or project boundary, we would add to this c.i.f. value the cost of domestic transport and domestic handling, reduced by the standard conversion factor, to obtain an economic import parity value of Rs453,124 [450,000 + (3,750 x 0.833) _ 453,124].

It is clear that to derive the import and export parity values in the economic analysis we must omit transfer payments, allow for the foreign exchange premium, and use shadow prices for those domestic goods and services for which prices are inaccurate indicators of opportunity cost. The same examples from the Sudanese and Nigerian projects used to illustrate the discussion of import and export parity prices in chapter 3 (tables 3-3 and 3-4) are used again in tables 7-2 and 7-3 to show economic parity values using both the shadow exchange rate and the conversion factor to allow for the foreign exchange premium.

Trade Policy Signals from Project Analysis

Up to this point, we have been discussing an analytical system that estimates the contribution of a proposed project to national income within a policy framework that the project analyst considers will exist during the life of the project. We have assumed that the project analyst has very little influence on trade policies, for this is true in the agriculture sector in most countries. Questions often arise, however, about the effects on a proposed project if trade policies were to change, and about whether changes in trade policies should be recommended. Unfortunately, when assessing the effects on a project of policies that would lift or impose a ban on trade, the analytical issues become very complex, and the analysis of a single project is of limited usefulness. The limitations of project analysis in influencing policy arise from the partial nature of project analysis and from the assumption that the project investment does not significantly change price relations in the economy as a whole.

Two important cases involving trade policy often arise that cause soul-searching among project analysts. The first is when a quota or prohibitive tariff prevents entry of a crucial input-perhaps fertilizer-

Table *7-2. Economic Export Parity Value of Cotton, Rahad Irrigation Project, Sudan* (1980 forecast prices)

*Steps in thecalculation*CAI at point of entry	*Relevant steps inthe Sudanese exampleUsing shadow exchange*C.i.f. Liverpool taken asestimate for all	*Lintrate*	*Value per ton-Seed*
	European ports)	US$639.33	US$103.39
Deduct unloading at			
point of import	Freight and		
Deduct freight to		- 39.63	- 24.73
point of import	insurance		
Deductinsurance			
Equals f.o.b. at point			
of export	F.o.b. Port Sudan	US$599.70	US$78.66
Convert foreign currency	Converted at shadow		

to domestic currency	exchange rate of		
at shadow exchange rate	^Sd1.000 = US$2.61lb	^Sd229.682	^Sd30.126
Deduct local port	Port handling cost		
charges	Lint: ^Sd5.564 per ton	- 5.564	
	Seed: ^Sd1.510 per ton		- 1.510
Deduct local transport	Freight to Port Sudan		
and marketing	at ^Sd6.782 per ton	- 6.782	- 6.782
costs from project to			
point of export (if not			
part of project cost)			
Equals export parity	Export parity value		
value at project	at gin at project		
boundary	site	^Sd217.336	^Sd21.834

Scartoa

Conversion allowance	Convert to seed cotton	86.934	12.882	1.102
if necessary	(^Sd217.336 x 0.4			
	+ ^Sd21.834 x 0.59		^Sd100.918	
	+ ^Sd110.200 x 0.01)°			
Deduct local storage,	Ginning, baling, and			
transport, and	storage (^Sd15.229			
marketing costs (if not	per ton)		- 15.229	
part of project cost)				
	Collection and internal			
	transfer (^Sd1.064			
	per ton)		- 1.064	
Equals export parity	Export parity value			
value at farm gate	at farm gate		^Sd84.625	
	Using conversion factors			

C.i.f. at point of entry	C.i.f. Liverpool (taken as			
	estimate for all			
	European ports)	US$639.3 3	US$103.39	
Deduct unloading at				
point of import	Freight and			
Deduct freight to		- 39.63	- 24.73	
point of import	insurance			
Deduct insurance				
Equals f.o.b. at point				
of export	F.o.b. Port Sudan	US$599.7 0	US$78.66	
Convert foreign currency	Converted at official			
to domestic currency	exchange rate of			
at official exchange	^Sd1.000 = US$2.8726	^Sc1208.8 09	^Sd27.389	
rate				

(Table continues on the following pages.)

Table 7-2 (continued)

Steps in thecalculation	Relevant steps inthe Sudanese example	ValueLint	per ton-Seed	Scar toa
Convert nontraded goods	Converted using			
to equivalent domestic	standard conversion			
value using conversion	factor of 0.909[6]			
factors				
Deduct local port	Port handling cost			
charges	Lint: ^Sd5.564 per ton	5.058		
	Seed: ^Sd1.510 per ton		1.373	
Deduct local transport	Freight to Port Sudan			
and marketing	at ^Sd6.782 per ton	6.165	- 6.165	
costs from project to				
point of export (if not				

part of project cost)				
Equals export parity	Export parity value			
value at project	at gin at project			
boundary	site	^Sd197.58 6	^Sd19.851	-
Conversion allowance	Convert to seed cotton	79.034	11.712	1.00 2
if necessary	(^Sd197.586 x 0.4	I		I
	+ ^Sd19.851 x 0.59			
	+ ^Sd110.200 x 0.909		^Sd91.748	

Deduct local storage,	Ginning, baling, and	
transport, and	storage (^Sd15.229	
marketing costs (if not	per ton)	- 13.843
part of project cost)		
	Collection and internal	
	transfer (^Sd1.064	
	per ton)	- 0.967
Equals export parity	Export parity value	
value at farm gate	at farm gate	^Sd76.938

^Sd Sudanese pounds.

Source: Adapted from World Bank, "Appraisal of the Rahad Irrigation Project," PA-139b (Washington, D.C., 1973; restricted circulation), annex 16, table 6. The format of the table is adapted from William A. Ward, "Calculating Import and Export Parity Prices," training material of the Economic Development Institute, CN3 (Washington, D.C.: World Bank, 1977), p. 9.

a. Scarto is a by-product of very short, soiled fibers not suitable for export and is sold locally at a price of ^Sd110.200 per ton.

b. For purposes of illustration, there is assumed to be a foreign exchange

premium of 10 percent. Thus, the dollar value of the Sudanese pound at the official exchange rate of ^Sd1.000 = US$2.872 has been divided by 1.1 to give an assumed shadow exchange rate of ^Sd1.000 = US$2.611 (2.872 - 1.1 = 2.611), whereas the standard conversion factor is divided by 1 plus the foreign exchange premium, or 0.909 (1 - 1.1 = 0.909). In the appraisal report that is the source of this table, no foreign exchange premium was assumed.

c. Seed cotton is converted to lint, seed, and scarto assuming that a ton of seed cotton yields 400 kilograms lint, 590 kilograms seed, and 10 kilograms scarto.

and this forces use of a more costly domestic alternative and thus greatly reduces the contribution of the project to national income. The second is when an import quota imposed on products that compete with the project's output makes the contribution of the project investment to national income high, even though the cost of production per unit of output from the project is higher than the cost of competing imports.

When the domestic cost of an important project input is higher than the world market price because of a quota or prohibitive tariff, the potential contribution of the proposed investment to national income

Table *7-3. Economic Import Parity Value of Early Crop Maize, Central Agricultural Development Projects, Nigeria*

(1985 forecast prices in 1976 constant terms)

Steps in the calculation

Relevant steps in the Nigerian example	Value per ton
F.o.b. at point of export	
Add local transport and marketing costs to relevant market *Equals* value at market *Conversion allowance* if necessary	
Deduct transport and marketing costs to relevant market	
F.o.b. at point of export	
Add freight to point of import *Add* unloading at point of import *Add* insurance *Equals* c.i.f. at point of import *Convert* foreign currency to domestic currency at shadow exchange rate *Add* local port charges	
Using shadow exchange rate F.o.b. U.S. Gulf ports No. 2 U.S. yellow corn in bulk'	US$116
Freight and insurance	31
(Included in freight estimate)	
C.i.f. Lagos or Apapa	US$147
Converted at an assumed shadow exchange rate of 4'q1 = US$1.47[6]	X100
Landing and port charges (including cost of bags)	22
Transport (based on a 350-kilometer average)`	10
Wholesale value	x#132
(Not necessary)	
Primary marketing (includes assembly, cost of bags,	

and intermediary margins)`	-12 Transport (based on a
350-kilometer average)`	-10 Storage loss (10 percent of
harvested weight)	-9

Deduct local storage, transport, and marketing costs

(if not part of project cost) *Equals* import parity value at farm gate

Add freight to point of import *Add* unloading at point

of import *Add* insurance *Equals* c.i.f. at point of import *Convert* foreign currency

to domestic currency at official exchange rate

Import parity value

at farm gate	x#101 *Using conversion factors*
F.o.b. U.S. Gulf ports	
No. 2 U.S. yellow corn in bulk'	US$116
Freight and insurance	31
(Included in freight estimate)	
C.i.f. Lagos or Apapa	US$147 Converted at official
exchange rate of	
:~il = US$1.62[6]	X91

Table 7-3 *(continued)Steps in the calculation*	*Relevant steps in Valuethe Nigerian example perton*
Convert nontraded goods	Converted using standard
to equivalent domestic	conversion factor of *0.909*[b]
value using conversion	
factors	
Add local port charges	Landing and port charges
	(including cost of bags, *X22) 20*
Add local transport	Transport (based on a
and marketing costs	350-kilometer average, *X10)` 9*
to relevant market	

Equals value at market	Wholesale value *X120*
Conversion allowance	
if necessary	*(Not* necessary)
Deduct transport	*Primary* marketing (includes
and marketing costs	assembly, cost of bags,
to relevant market	and intermediary margins, **12)` - 11*
	Transport (based on a
	350-kilometer average, *X10)` - 9*
Deduct local storage, transport,	Storage loss (10 percent of
and marketing costs	harvested weight) - *8*
(if not part of project cost)	
Equals import parity value	Import parity value
at farm gate	at farm gate *x#92*

Nigerian naira.

Source: Adapted from World Bank, "Supplementary Annexes to Central Agricultural Development Projects," *1370-UNI* (Washington, D.C., *1976;* restricted circulation), supplement 11, appendix *2,* table *4.* The format of the table is adapted from Ward, "Calculating Import and Export Parity Prices," p. 10.

a. Forecast from *Price Prospects for Major Primary Commodities (1976,* annex *1, p. 12;* see World Bank *1982a).*

b. For purposes of illustration, there is assumed to be a foreign exchange premium of 10 percent. Thus, the dollar value of the naira at the official exchange rate of **1 = US$1.62* has been divided by 1.1 to give an assumed shadow exchange rate of *=P-~ 1 = US$1.47 (1.62 - 1.1 = 1.47),* whereas the standard conversion factor is 1 divided by I plus the foreign exchange premium, or *0.909 (1 - 1.1 = 0.909).* In the appraisal report that is the source of this table, no foreign exchange premium was assumed.

c. Shadow prices were assumed for transport and for primary marketing because in the financial analysis the market wage overvalued the opportunity cost of unskilled labor. The value given is the opportunity cost in naira (before applying the standard conversion factor).

will be reduced by the tariff or quota. *Given the policy prevailing,* the project analysis will be an accurate indicator of the project's worth. Take fertilizer, for instance. If it is expensive to produce domestically, this is an indication that fertilizer production uses a large amount of scarce domestic resources relative to the resources necessary to produce some other product that could be exported to earn the foreign exchange needed to import the fertilizer from a foreign supplier. But if the domestic fertilizer must, in fact, be used for the project to move forward, then it will take a lot of domestic resources to produce the project's agricultural output, and the project will not, accordingly, make as much of a contribution to the national income as it could were imported fertilizer available. If the quota or prohibitive tariff against the input were removed, then the project investment would look quite different. A change in trade policy, however, will have implications ranging far beyond the boundary of the project itself, implications for both efficiencies in the economy and for noneconomic objectives. A change in trade policy may bring a wide range of changes in other prices in the economy as well as in the price of fertilizer used on nonproject farms, and to be valid an investment analysis would have to be run with the new price relations and include nonproject farms. Predicting these changes could be very difficult if the change in trade policy were significant. At best, the project analyst could run his analysis again using a c.i.f. price for fertilizer and making a broad guess about what the changes might be in the rest of the economy both within and outside agriculture., He could then turn to those responsible for trade policy and say that his project analysis signaled a need to consider with care removing the quota against fertilizer. But note that the project analysis is only a signal, not a criterion for decision; much, much more must go into a reevaluation of trade policy than the analysis of one project.

The other important case in which a change in a quota proves very difficult for the project analyst is that of a quota against imports that would compete with the output of a proposed project. If the imports are prohibited, the output of the project will sell for more in the protected market, and what otherwise might not be a very attractive project may now make sufficient contribution to national income to be justified. Again, i f *policies are not going to be changed*, this is an accurate indicator of the contribution to the national income. But if the domestic cost per unit of project output-say, apples-valued at shadow prices is greater than the c.i.f. cost of imported apples, then this is an indication that it would be more efficient from the standpoint of the economy as a whole for the project to produce something else, export it to earn foreign exchange, and then use the foreign exchange to import apples. Under the circumstances, the project analyst may want to run his analysis again using an import parity price and perhaps also adjusting some of the other price relations in the direction he thinks might prevail under a change in trade policy. He may find that domestic production would not make enough of a contribution to national income at these prices to justify the investment required. He might also want to determine the domestic resource cost of the import substitute along the lines discussed in the section of chapter 10 devoted to that topic; this will show that it costs more to save a unit of foreign exchange by producing apples domestically than the shadow exchange rate indicates the foreign exchange to be worth. His analysis has now signaled that trade policies should perhaps be reviewed. Again, it is only a signal; the analysis of this one project does not itself provide a complete decision criterion. The trade policy change will have many other effects that will be felt far beyond the boundary of the project itself.

Valuing Intangible Costs and Benefits

The methodology outlined for converting financial prices to economic values is one that is most appropriate for tangible costs and benefits. When intangible costs or benefits enter into investment considerations, they raise difficult issues of valuation.

Intangible factors have come up frequently in earlier discussions of identifying costs and benefits and of valuing them. They comprise a whole range of considerations-economic considerations such as income distribution, number of jobs created, or regional development; national considerations such as national integration or national security; and environmental considerations that can be both ecological and aesthetic, such as the preservation of productive ecosystems, recreation benefits, or famous spots of scenic beauty. [Lee (1982) discusses ecological considerations to be kept in mind when designing agricultural projects for tropical regions.]

The question of how to treat intangible factors most often arises when we are considering the benefits of a project. Many development projects are undertaken primarily to secure intangible benefits--education projects, domestic water supply projects, and health projects are a few common ones. Intangible benefits are usually not the major concern in agricultural projects, although many agricultural and rural development projects include components such as education or rural water supply from which intangible benefits are expected. Whether in agricultural projects or in other kinds of projects, intangible benefits, even though universally agreed to be valuable, are nevertheless virtually impossible to value satisfactorily in monetary terms. Yet costs for these projects are in general tangible enough, and the considerations of financial and economic valuation we have discussed earlier apply unambiguously.

Intangible costs are not uncommon, however, and prove just as difficult to bring within a valuation system as benefits. Often costs are merely the inverse of the benefits that are sought: illiteracy, disease, unemployment, or the loss of a productive environment or treasured scenic beauty.

Some costs in agricultural projects, while tangible, are very difficult to quantify and to value. Siltation, waterlogging, salinization, and soil loss are examples. These costs should not be ignored, and if they are likely to be substantial they should be treated in the project analysis in a manner analogous to intangible costs.

When considering projects in which intangible benefits or costs are important, the least the project analyst can do is to identify them: lives that will be saved, jobs created, kind of education provided, region to be developed, location of a park, ecosystem or kind of scenery to be preserved.

Very often, the analyst can also quantify intangibles: number of lives saved, number of jobs created, number of students to be enrolled, number of people expected to use a park. Even such simple quantification is often a substantial help in making an investment decision.

Economists have tried repeatedly to find means to value intangibles and thus bring them within the compass of their valuation system. The benefits of education have been valued by comparing the earnings of an educated man with those of one who is uneducated. Health and sanitation benefits have been valued in the number of hours of lost work avoided by decreasing the incidence of disease. Nutrition benefits have been valued in terms of increased productivity. Population projects have been valued by attaching a value to the births avoided. Although work in these areas continues-especially with regard to environmental impact-few applied project analyses in developing countries currently attempt to use such approaches to valuing intangible costs and benefits. For one thing, such efforts generally greatly underestimate the value of the intangibles. The value of an education is much more than just the increase in income-ask any mullah, monk, or priest. Good health is a blessing far in excess of merely being able to work more hours. Good nutrition is desirable for more reasons than just increased productivity. Moreover, the methodological approaches used to value intangibles turn out to be unreliable and open to serious question. Finally, there may be moral issues involved-many who support population programs do so out of considerations that extend far beyond any benefit-cost calculation.

In contemporary practice of project analysis in developing countries, the only method used to any extent to deal with intangible benefits is to determine on a present worth basis the least expensive alternative combination of tangible costs that will realize essentially the same intangible benefit. This is often referred to as "least-cost combination" or "cost effectiveness" (for an application of the method to sanitation projects, see Kalbermatten, Julius, and Gunnerson 1982, chapter 3). If the same education benefits can be provided by centralized schools that realize economies of scale but require buses or by more expensive smaller schools to which students can walk, which schools are cheaper? Can the same health benefits be provided at less cost by constructing fewer large hospitals but more clinics manned by paramedical personnel? By constructing a waterborne sewerage system or by installing low-cost household sanitation facilities that do not require sewers? Can the same number of lives be saved more cheaply by buying up all the property rights in a flood plain and moving people out than by constructing dykes and levees? Given two park sites that would give similar recreation benefits-perhaps one that would require buying warehouse sites and another that would require extensive filling and flood control along a river-which would be cheaper? Once it is determined that the least expensive alternative has been identified and its costs valued, then the subjective question can be more readily addressed: is it worth it?

Interestingly enough, electricity projects are customarily analyzed

using least-cost combination. The marginal value product of electricity is in general considered greatly understated by the administered price charged; in any event, much electricity is used for home lighting that is very difficult to value. In practice, most power projects simply compare alternative means of producing the same amount of power: steam generating stations versus a hydroelectric dam; a large generator with transmission costs and several years of idle capacity versus a series of smaller stations close to the demand centers.

A variation of the least-cost combination method can be used to deal with intangibles in multipurpose projects. From the total cost of the project are deducted all those costs that can be directly attributed to tangible benefits-flood damage avoided, irrigation, navigation, and the like. These costs are compared with their associated benefits to determine if the purpose is worthwhile at all. Is the flood damage avoided worth the direct costs incurred? Finally, the residual costs for the project are compared with the residual, intangible benefits. Is the number of lives saved by the project worth the residual cost that must be incurred? (A method of allocating residuals was outlined in the section on joint cost allocation in chapter 6.)

The problems with valuing intangibles are more common and more difficult to deal with in sectors other than agriculture. In agricultural projects, most of the benefits usually are tangible and can be valued. The costs and benefits can be compared directly to choose the highest-yielding alternative. There are, however, several aspects of intangible benefits that are frequently encountered in agricultural projects. Agricultural extension services, for example, are sometimes considered to give an intangible benefit in greater farmer education. For the most part, it is best to treat such costs that may give rise partly to intangible benefits-or, at least, the incremental amount of such costs-as necessary within a project if the total, tangible benefits are to be realized. If a dairy production project requires helping farmers to learn better sanitation procedures, then the extension agents who teach the procedures are essential to the success of the project, and the benefit of their effort is the tangible one of more and better milk.

In rural development projects, there are often components that are hardly essential to the main production objectives and that produce generally intangible benefits. This is the case when village schools, rural water supplies, rural clinics, or even agricultural research costs are included in a project. If these components are relatively small in comparison with total project costs, as they often are, then the problem of valuing the benefits may be ignored. But if such components form a significant part of total project cost, they probably should be separated out and treated on a least-cost combination basis. This procedure was followed in the analysis for the Korea Rural Infrastructure Project. The project included irrigation, feeder roads, community fuelwood plots, rural domestic water supply, and rural electrification. The irrigation, feeder roads, and community fuelwood components were analyzed by

Figure 7-1, part A. *Decision Tree for Determining Economic Values: Major Steps*

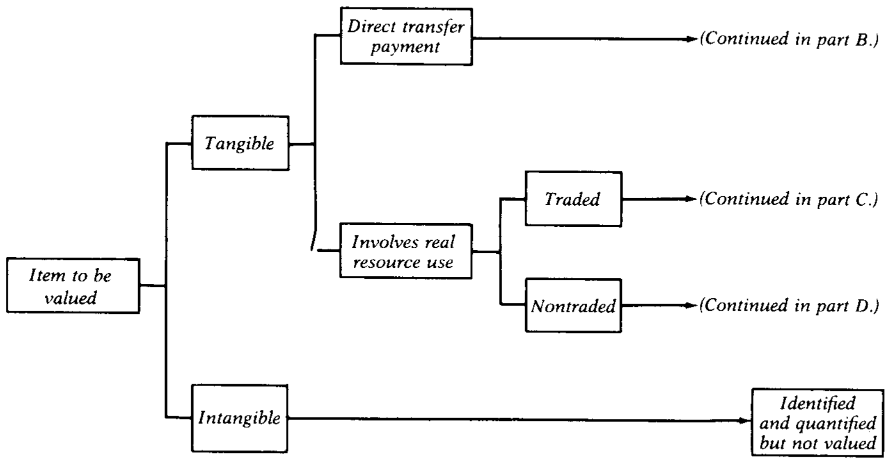


Figure 7-1, part B. *Decision Tree for Determining Economic Values: Direct Transfer Payments*

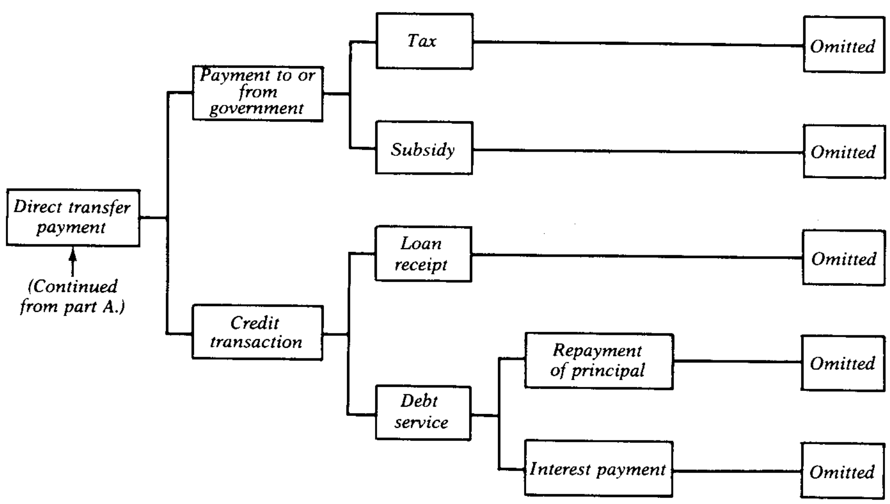


Figure 7-1, part C. *Decision Tree for Determining Economic Values: Traded Items*

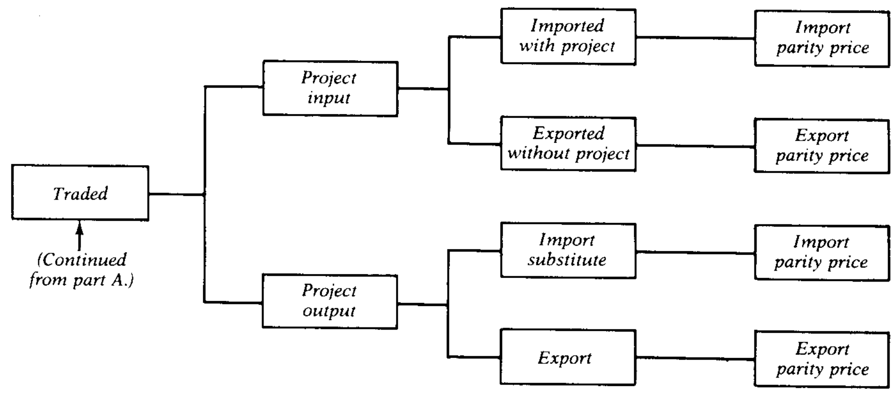
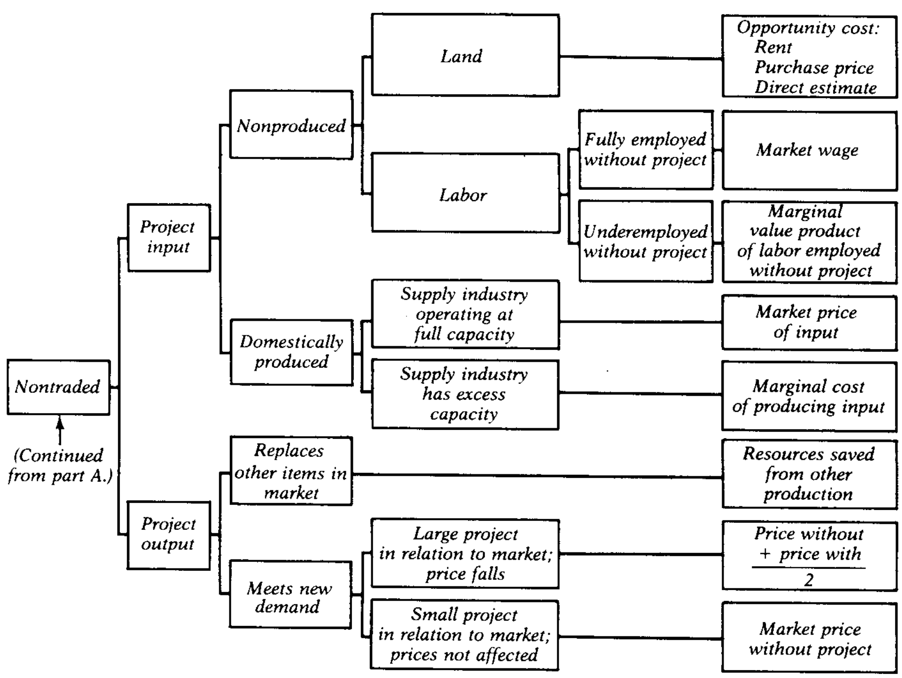


Figure 7-1, part D. *Decision Tree for Determining Economic Values: Nontraded Items*



Source: Adapted from William A. Ward, "Economic Valuation Decision Tree," training material of the Economic Development Institute (EDI), CN-61 (Washington, D.C.: World Bank, 1978).

comparing their tangible costs with their tangible benefits, but the components for rural domestic water supply and rural electrification were each dealt with separately on a least-cost combination basis.

Finally, if the proposed project is one in which the output is wholly intangible, a least-cost combination approach is appropriate. This would probably be the case for agricultural projects in which the major investment is in extension, agricultural education, rural water supply, rural health improvement, or research.

Decision Tree for Determining Economic Values

A "decision tree" for determining economic values is given in figure 7-1, parts A-D. Most issues of economic valuation in agricultural projects are covered by this diagram. The decision tree is used by taking an item to be valued in an agricultural project and tracing through the tree, following each alternative as it applies to the item until the end of the tree is reached, where a suggestion about how to value the item will be found.

To illustrate, we may trace through a few common elements in agricultural projects. Take fertilizer to be used in an irrigation project that will produce cotton. The fertilizer is tangible, involves real resource use, is traded, is a project input, and would be imported without the project. Therefore, it is valued at the import parity price. Or take agricultural labor to be used to apply the fertilizer. It is tangible, involves real resource use, is nontraded, is a project input, is nonproduced, is labor, and would be underemployed without the project. Therefore, it is valued by taking the marginal value product of the labor in its without-project employment. (Note that labor is defined as a tangible item, a possible source of confusion in using the decision tree.) Or take a tax on the fertilizer. It is tangible, is a direct transfer payment, is a payment to or from government, and is a tax. Therefore, it is omitted from the project economic account. Or, finally, take the cotton to be produced in the project. It is tangible, involves real resource use, is traded, is a project output, and will be an export. Therefore, it is valued at the export parity price.