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MANUAL for Agricultural Capital Project Analysis

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PREFACE

This manual has been prepared for use in conjunction with the USDA Agricultural Project Analysis Course, which is offered for planners, officials, and other key professionals of developing countries. The course itself is broader in scope and deals more fully with actual projects, linkages of projects to overall economic development, information gathering, and project implementation. At the heart of all this is prediction of the impacts of proposed projects, and wise selection among them. Getting accurate facts about costs and benefits is part of it. Equally important is the correct handling and interpretation of these facts. The focus of this manual is on the pivotal concepts and methods around which such "benefit-cost analysis" is built.

The purpose of the USDA course is not only to help participants themselves to analyze agricultural projects more effectively. Many are organizing and teaching similar courses in their home countries, as well as providing informal guidance to associates in efforts to improve project analysis procedures. Hopefully this manual, and the teaching suggestions it contains, can be useful in these undertakings.

We owe an obvious debt of gratitude to Dr. Price Gittinger and the World Bank's Economic Development Institute. The USDA course to which this manual relates was first offered in 1972 in response to needs expressed by counterparts of Department and AID personnel in Africa, Asia, and Latin America. The well received Agricultural Projects Course which Dr. Gittinger had developed at EDI was used as its "model". He has very generously provided materials, suggestions, and his own time toward helping the USDA course get underway. We are using his book, Economic Analysis of Agricultural Projects, as the main text. The analytical points which this manual highlights and illustrates are, in large part, those which Dr. Gittinger stresses.

The full eight-week USDA course has, since 1972, been offered three times in Washington to participants from a variety of countries. Shorter four-week versions have been conducted in Turkey, Jordan, Guyana, and the Dominican Republic. This experience has led to some changes in emphasis and sequence, so as to better fit the particular groups we are reaching. For example, we are inclined to explain "financial analysis" before getting into "economic analysis". This manual reflects these modifications, drawing especially on the suggestions of Ira Branson, John Hyslop, David Mateyka, and Lyle Schertz, who have been closely associated with the evolution of the course.

We are grateful to Robert Doan of ERS/FDD for his help in editing the manual. Appreciation goes also to Gloria McCaskill and Sue Gerlach of ERS/FDD, and to Melitta Stout and Teresa Jones of the University of Tennessee, for their assistance.

Finally, we urge users of this manual to convey to us their suggestions about how it could be improved as a learning aid. Perhaps other topics should be included or changes made. Hopefully this will stimulate other teachers to try new methods, or to develop better illustrations and visual aids. We would like to hear about such ideas.

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Part A

Overview

PART A
AN INTRODUCTORY OVERVIEW

** *How helpful will this proposed development project be to the economic growth of our economy?*

** *To what extent will it be self-supporting?*

** *How attractive is it as an investment to lending institutions?*

** *What income impacts will it have on farmers and other specific groups?*

** *Will the project have other effects on the people such as increased employment, better food, and better health?*

** *Suppose there are unforeseen delays, crop failures, or price declines. How severe would the repercussions be?*

** *Are there other projects that would represent better use of our limited funds?*

** *What effect will it have on the distribution of income and wealth?*

** *Does it have particular implications for the environment?*

These are questions that must be answered when evaluating project proposals. While they should always be considered, they become expecially important when large amounts of funds, long-term commitments, and international assistance are involved. The objective of this course is to suggest and explain some methods that are useful in appraising project feasibility and comparing the costs and benefits of alternative investment possibilities.

There is no "perfect" method of analyzing and evaluating projects. The best possible method will vary from situation to situation. Instead of memorizing certain hard-and-fast procedures, emphasis should be placed on gaining a basic understanding of certain key concepts related to selecting, collecting, and analyzing relevant information. Case examples will be used to provide practice in applying these concepts to specific situations similar to those existing in the countries of participants.

But first, some general background...

1. What We Mean by "Projects"

Our attention will be focused on action proposals related to agriculture or rural areas which a) would be initiated by government or another entity beyond the level of the individual farmer or businessman; b) would entail large capital investment; and c) would be aimed largely at paving the way for increases in productivity and/or incomes. For example:

Irrigation schemes	Farm-to-market roads
Flood-control projects	Fertilizer plants
Land settlement projects	Agricultural research facilities
Grain storage facilities	Machinery pools
Permanent crop replanting schemes	Co-op processing plants
Rural industrialization	Credit for livestock improvement
Rural electrification	Reforestation
Area pest control	Production and distribution of improved seed

Such projects may or may not be financed or managed by government line agencies. Other financing and administering entities might include: quasi-government corporations, special development authorities, cooperatives, producer associations, and even private corporations or banking institutions having special mandates to do certain things in the "public" interest. Project finance and management may rest in different groups; for example, funding for a cottage industry project may come from the national ministry of rural development, with the project itself being administered by a local co-op. Some projects, such as comprehensive irrigation schemes, may involve several organizations (sometimes without clearcut lines of responsibility or a single coordinating group).

Some other kinds of actions related to agriculture and rural people are very important, but do not lend themselves so readily to quantitative analysis -- for example, land tenure reform, community development, improvement of rural health services, extension home economics education, and agricultural university development. In these types of activities, intangible objectives become very important, and capital investment is not always the major requirement. Nonetheless, benefit-cost considerations do need to be considered and the methodologies presented in this course can be useful in evaluating such "non-capital" projects, when used to supplement other indicators of project impacts.

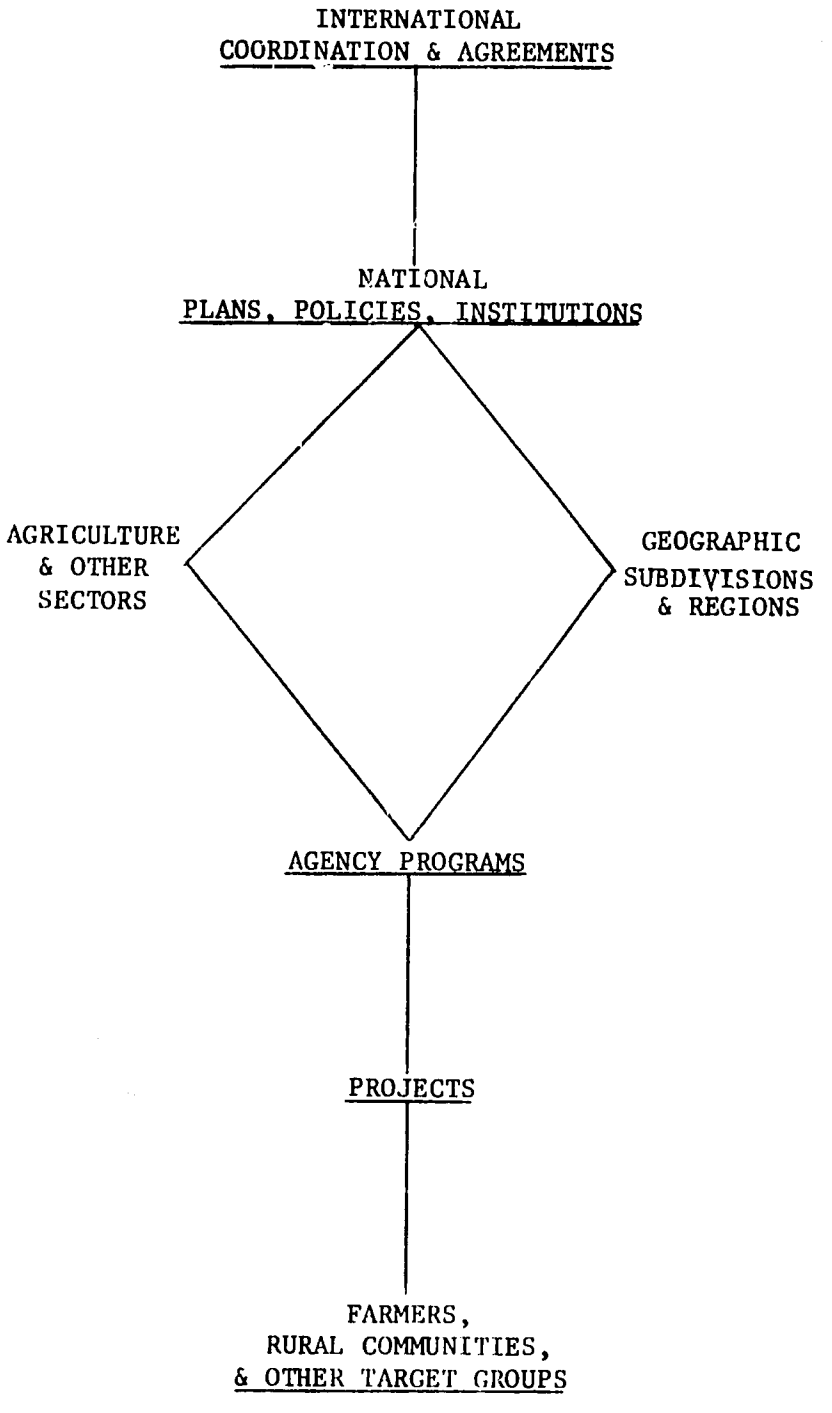

Figure A-1. Projects as one of several development planning and action levels.

2. How Projects Fit into the Development Picture

The project level is only one of several levels at which development activities can be analyzed. (See figure A-1.) At the agency program level there is need to make wise choices about which projects to undertake and how best to blend them together. At the broader sector and regional levels, the cumulative programs and projects of various agencies may be assessed as to how things are adding up in terms of production, employment, or whatever else may be of concern. Analysis at the national level bears especially on formulation of basic strategies for achieving development objectives and, in turn, establishment of policies, laws, organizations, price systems, and financial sources to undergird the proposed actions. And to an ever-increasing degree, there is need for cooperative planning at the international level to reduce conflict and increase effectiveness in the use of the world's scarce natural and capital resources.

The project represents the basic operational level at which the various elements -- funds, materials, technical expertise, manpower, legal authority, etc. -- are brought together to produce a change in the agricultural setting which has a direct and tangible impact on the opportunities open to farmers and other target groups. It is also at the project level that particular attention has to be given to more detailed planning of action components, implementation steps, and financial needs.

It should be noted that projects involving a large capital investment are not the only forms of development action which have important "grassroots" effects. While not as visible as a dam, processing plant, or road, such projects as the expansion of extension service schools, veterinary clinics, regulation of weights and grades and soil testing are very helpful aids to agricultural development. Effective meshing with supportive services of this sort can have a great deal to do with the changes in production or income generated by a new project. And more than in the past, agricultural ministries and international assistance agencies are planning for the upgrading of such supportive activities as integral components of investment project proposals.

3. Analysis as Part of the Project Cycle

This course will highlight the analysis of projects with respect to their financial and economic viability. It is essential that this analysis be comprehensive enough to consider what effects the project would have on such elements as employment and income distribution. But this is only one of a whole series of steps entailed in evolving a development project. It is useful to divide the evolution of a project into three phases: 1) planning, 2) implementation, and 3) evaluation. As shown in figure A-2, each phase involves attention to several important elements.

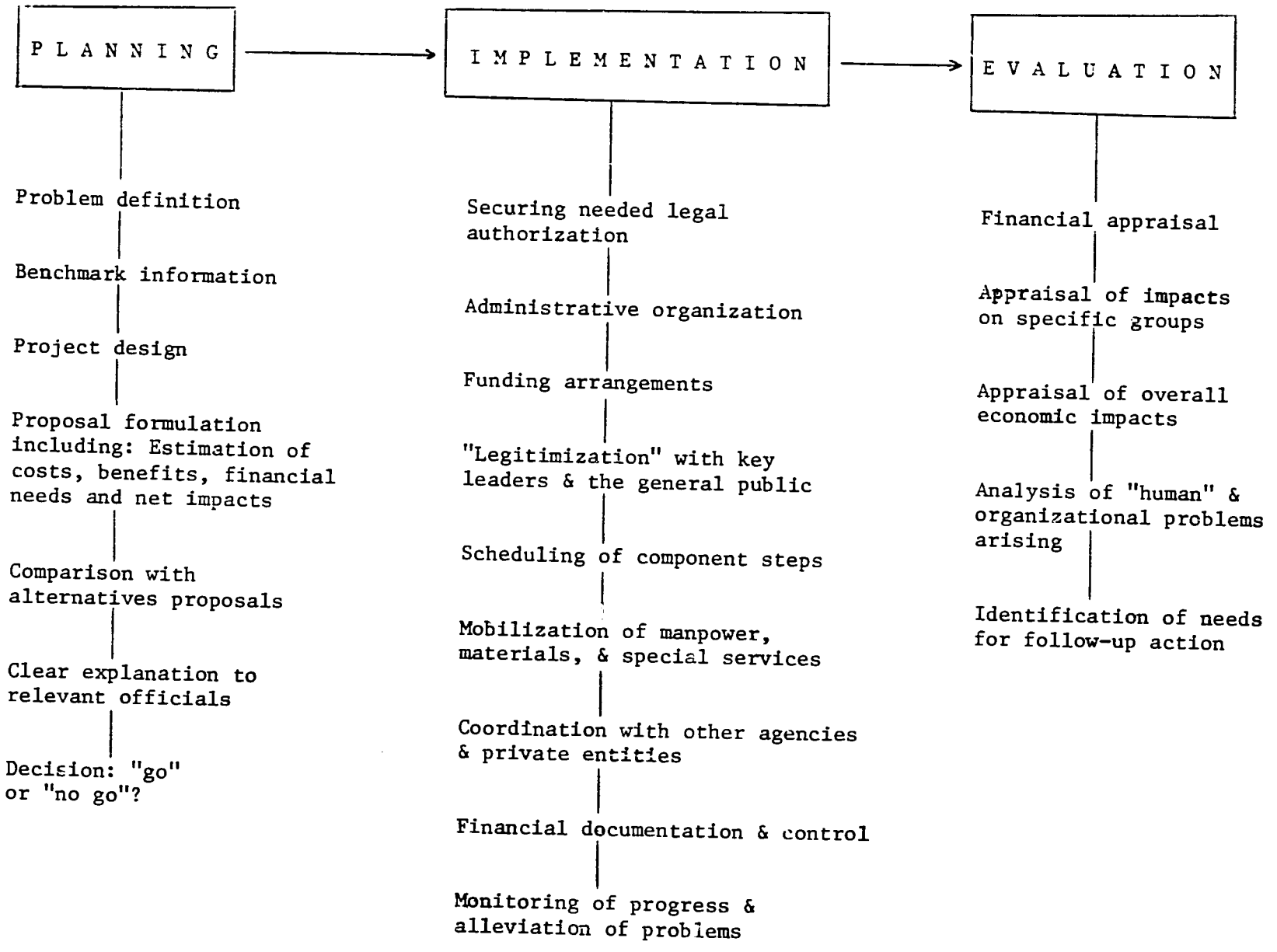

Figure A-2. Components of project evolution.

Once the problem has been defined and a preliminary project proposal formulated -- but before it is actually implemented -- there is need to predict what its financial requirements will be, and what impacts it will have on both specific groups and the economy as a whole. There is need also to compare the likely results of a project with results of alternative projects that may compete for the same funds. A widely used methodology for determining the economic and financial viability of a project(s) is referred to as benefit-cost analysis. Benefit-cost analysis is applicable primarily to the planning phase of the project. It is this analysis that provides country officials (as well as international lending agencies, if they are to be involved) with a basis for deciding whether to go ahead with the project. This appraisal process can have any of five possible outcomes; it can be decided:

a. To fund and implement the project as initially proposed.

b. To abandon the project as not feasible or sufficiently productive.

c. To give another project higher priority, and delay this project until later.

d. To modify the project proposal to reduce certain weak features or to be more in keeping with available funding.

e. To defer final action about the project until more complete or accurate facts about probable results can be obtained.

In practice, project analysis and other stages of project evolution are closely intertwined. Implementation complexities need to be taken into account when estimating benefits and costs. The benefit-cost analysis may bring to light certain weaknesses that could be eliminated by reshaping the basic design or scale of the project. Unforeseen changes in prices or other circumstances once the project is underway may make it desirable to re-analyze the project, with a view toward altering plans for the remaining stages or maybe even abandoning it uncompleted.

The methods presented in this course will be applied mostly to the analysis of proposed projects before they are implemented. However, the same methods can be adapted to the evaluation of projects after they have been completed or have reached certain stages. Such "post-project" evaluation is sometimes done by planners and assistance agencies for any of five reasons:

1. To keep abreast of the production and economic changes being generated by the project.

2. To spot departures from planned impacts and timing that may require additional action or changes in repayment schedules.

3. To obtain an accurate picture of the costs, benefits, and time periods actually entailed, so that there will be less error when analyzing similar project proposals in the future.

4. To document project results for purposes of generating public enthusiasm for the kind of development undertaking involved (not to mention political support for the leaders and agencies associated with the project!).

5. To generate information useful in deciding to continue, adjust, or control project activities.

One has to be careful when reviewing an evaluation of completed projects to make sure that the information is indeed objective and has not been distorted for "promotional" purposes.

4. The Heart of Project Analysis --- Benefits and Costs

Financial and economic analysis of projects centers around one basic notion -- estimation, as best one can, of the costs and benefits likely to be brought about by the project if it were to be undertaken.

Take a proposal to build a dam to reduce flooding in an agricultural valley. Initial costs will be incurred for acquiring a dam site and constructing it. In subsequent years there will be costs for keeping the dam in good condition. The reduction in flooding and crop damage brought about by the dam may result in higher yields and more income for farmers in the valley. In addition, many farmers may shift to new, more profitable types of farming that were not feasible before the dam, or they may start using lowland areas that were previously idle. This would result in more new income and, along with it, additional farming costs they did not have before the dam was built.

If you think about it further, there may be some other costs and benefits that should be taken into account. For example, the lake created by the dam may mean a new road has to be constructed and that people have to travel longer distances to town. The extra money earned and spent by farmers may generate more business for local merchants and, in turn, more job opportunities. The lake itself may attract tourists who bring new income into the area but who, at the same time, may wear out local roads faster.

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How far to go in including such costs and benefits, and how to value them, is one of the questions never completely resolved in project analysis. The best answer will depend on the particular nature of the specific project and the purpose for which the analysis is being done. The main thing is to include the major changes expected to result from the project...changes relative to the situation that would exist during the same time period if the project were not undertaken. As Gittinger puts it, the differences in benefits and costs with and without the project are what count.[1/]

Further it is important to recognize that the costs considered in financial analysis may be different from the costs considered in economic analysis. The same is true with respect to benefits. The differences involve the type of items considered, as well as the per unit values (prices) utilized.

5. How Benefit-Cost Analysis is Used

These benefit-cost estimates can be used by decision-makers in development and finance agencies in two basic ways:

a. To determine the viability of the project in its own right -- usually, viability in terms of i) financial needs and returns of the project as an entity, ii) impacts on specific groups affected by the project (often farmers, especially, in the case of agricultural projects), and iii) net economic benefits to the nation as a whole.

b. To compare these impacts with those likely to be forthcoming from alternative projects that could be considered -- either similar projects in other places, or other kinds of development undertakings.

If it is revealed that the project is going to be excessively expensive while making only a minor contribution to the nation's economic development, it usually would not make sense to go ahead with it.

However, even if the benefits and costs of a particular project promise to be favorable, the project should be compared with alternative projects. As a result of this comparison, the initial project might be rejected or delayed if it is discovered that one of the alternative projects provides a more productive use of the same funds.

[1/] For more about this "with" and "without" distinction, see J. Price Gittinger, Economic Analysis of Agricultural Projects (Baltimore: Johns Hopkins, 1972), p. 15 and elsewhere.

Since financial and other resources in developing countries are often very scarce, this latter consideration -- what economists call the opportunity cost of an investment -- is especially important. Everything cannot be done at once; alternatives have to be considered and hard choices have to be made. The benefit-cost methodology we shall be discussing can be used not only to appraise a project's own merits, but also to help establish priorities and to sort out less productive proposals from the more productive.

6. Summarizing and Comparing Project Effects

When analyzing how proposed projects stack up against one another, it is difficult to make meaningful comparisons by merely inspecting "raw" estimates of benefits and costs. Two projects may have similar net results, but one may require considerably more funding than the other. Or one may promise quick impacts, whereas the other may take 10 or 15 years before its benefits show up.

For this reason it is necessary to place benefit-cost estimates for alternative projects on a comparable basis. As we shall see, "discounting" of annual benefits and costs is a procedure often used to compare projects that involve extended periods of time. There are certain other indicators that are useful for summarizing overall project results. These include the "benefit-cost ratio," "net present worth," and "internal rate of return."

Here again, no single procedure or indicator will be best for evaluating each and every project. Each has its advantages and its limitations. Indeed, a major task of the project analyst is to cast benefit-cost information into a mold that best fits the considerations being taken into account by officials when comparing projects. On occasion, it may even be desirable to "invent" new indicators of your own!

Beyond the basic comparison of project costs and benefits, some supplementary analysis of projects may be helpful. For example, if future commodity prices are very uncertain or crop yields fluctuate widely from year to year, "sensitivity analysis" (discussed later) may help in appraising risks associated with the project. Or, if certain considerations other than money are important to decision-makers, (such as impacts on rural unemployment, nutrition, or environmental quality), project effects could be measured in terms of additional kinds of performance indices. These "other" considerations are currently receiving more and more attention by developing countries and assistance agencies and better ways to integrate them into project analysis need to be found. Perhaps in years to come you can have a part in devising improved measures of "non-money" project impacts.

7. Project Analysis -- From Whose Standpoint?

The benefits and costs to be included in the analysis of a project, and the way they are handled, depend on the perspective from which the project is to be viewed. That of the individuals who will be directly affected? The organization which will administer the project? The institution financing the project? The nation as a whole? Or who? (Any given project may be analyzed from more than one viewpoint.) It is important for the analyst to recognize through whose eyes he is assessing the project.

There may be others of importance but, for agricultural projects, usually three entities are of special interest to potential sponsors:

a. Farmers who are directly affected by the project (usually focusing on "typical" individual cases), to ascertain the changes in farming practices and production they are likely to make, the effects these changes will have on their income, and their ability to meet any new financial obligations brought about by the project.

b. The organizations primarily responsible for managing or financing the project (a cooperative, processing plant, government agency, project authority, etc.), to ascertain its investment and operating requirements, potential revenues, and capacity to repay funding advanced for the project.

c. The economy as a whole (usually the nation in which the project is to be located), to ascertain what the overall net effects of the project are likely to be on economic growth, income streams, and resource productivity.

Appraisal of project impacts from the first standpoint (farmers and other specific project-related entities) is called financial analysis, since the basic question is: will the individuals gain enough to act as expected and to meet payment commitments resulting from the project? The analysis from the last viewpoint -- that of the whole economy -- is called economic analysis, where the basic question is: to what extent will society gain in terms of its economic growth objectives as a result of the project? Estimating overall economic benefits is not necessarily a matter of simply adding up the costs and returns of all the individual farmers (or other entitites) affected by a project; from a national perspective, the specific items to be included and the basis for valuing them may be quite different.[2/]

[2/] For more about this distinction between "financial" and "economic" analysis, see J. Price Gittinger, Economic Analysis of Agricultural Projects, pp. 4-8 and elsewhere.

8. Predicting What Actually Will Happen is the Aim

Regardless of the manipulations that are performed, project analysis can be no better than the benefit and cost information on which it is based. Doing it well usually entails fairly tedious assembly and blending of information from a variety of sources -- engineers' calculations of construction needs and performance rates...farm-level estimates of prospective yields and input requirements...projections of prices...many other details of this sort. Especially where innovative new undertakings are proposed, "hard facts" may be scarce; considerable guesswork and firsthand investigation may be necessary.

In all of this, it is crucial to remember that the objective of the analysis is to forecast what would actually take place as a result of the project, in the particular setting and during the particular time period in mind. This may be quite different from what would ideally happen if everything went well, or what has happened in the past, or what is happening in other places. Information from similar projects elsewhere, as well as studies done for other purposes, can usefully be drawn upon. But care must be taken that these data are appropriately adjusted to fit the particular circumstances at hand, and that predictions are realistic.

The danger of such error is especially notable in analyses of agricultural projects, which often depend heavily on information about farm-level impacts. Cropping possibilities and yield potentials vary widely from place to place. Yields actually obtained by farmers may fall short of what experiments conducted under ideal management lead agronomists to expect. For various reasons, many farmers may not take advantage of the new opportunities afforded by the project. Since commodity prices fluctuate, it cannot be assumed that current prices will continue.

It is also important that nonmoney effects of the project also receive consideration. Measurement of income gains by farmers or benefits to the society is a good way to compare projects. However such noneconomic benefits as a better diet and improved health of rural people may be major benefits of a crop or livestock production project.

Projects which reach the people with the lowest income may have important equity benefits by providing employment and increased income for this segment of the population.

There are many primary and secondary effects of most projects. Projects that increase exports or tend to decrease imports through import substitution may have a favorable effect on the country's balance of payments.

In general the nonmoney or noneconomic benefits are more difficult to assess than economic benefits. They should be given consideration when a project is analyzed.

9. In Summary

What all this adds up to is that analysis and comparison of proposed projects involves a procedure like the following:

a. Becoming acquainted with the key features of the proposals, the setting in which it would be implemented, and the entities that would be involved.

b. Finding out from relevant decision-makers what are the important criteria for judging the proposals. (This could include considerations other than the core questions of financial viability and economic benefits and costs.)

c. Choosing the specific measures of project impacts, as well as determining whose viewpoints will be emphasized (farm level, project agency level, the overall economy, etc.).

d. Obtaining the benefit-cost information (such as employment effects) needed to develop estimates of project effects. (Often the facts provided in the original proposal will be insufficient; additional information from technicians, economists, farmers, etc. may be required. Emphasis is on the <u>changes</u> likely to stem from the projects.)

e. Blending and transforming the benefit-cost data and other information into analytical form (adjusting to reflect likely future events, putting "with"-and-"without" project estimates on a comparable basis, discounting annual figures for long-term projects, etc.).

f. Summarizing and presenting the results in a form that can be readily understood by those who will be making decisions on the project.

As we have mentioned, if the project is accepted and implemented, additional analysis may be needed at later stages. Changes in plans while the project is underway may require evaluation. Appraisal of actual performance after the project is completed may be desired.

Some General Readings on Agricultural Development and Project Analysis

Warren C. Baum, "The Project Cycle," pp. 2-13 in (IMF/World Bank) Finance and Development, vol. 7, no. 2, June 1970.

Avrom Bendavid, "The 'Concepts-Strategy-Projects' Approach to Planning for Regional Development," pp. 26-30 and 40 in International Development Review, vol. 14, no. 1, 1972. See also IDR, vol. 15, no. 3, 1973, pp. 35-39.

J. Price Gittinger, Economic Analysis of Agricultural Projects (Baltimore: Johns Hopkins, 1972). Ch. 1, "Projects: the 'Cutting Edge' of Development," pp. 1-14.

J. Price Gittinger, "Economic Analysis of Agricultural Projects," pp. 3-27 in (AID) Development Digest, vol. 11, no. 3, July 1973. (Summary of Gittinger's book of the same title.)

Earl M. Kulp, Rural Development Planning (New York: Praeger, 1970, pp. 26-99.

Robert P. Lima Netto, "Choosing among Proposals: the Making of Investment Decision," pp. 42-45 in (IMF/World Bank) Finance and Development, vol. 8, no. 2, June 1971.

J. W. Mellor, The Economics of Agricultural Development (Ithaca, N.Y.: Cornell, 1966. Ch. 5, "Agriculture and Capital Formation," pp. 81-101.

A. T. Mosher, Getting Agriculture Moving (New York: Praeger, 1966).

A. T. Mosher, To Create a Modern Agriculture (New York: Agricultural Development Council, 1971).

A. R. Prest and R. Turvey, "Cost-Benefit Analysis: A Survey." pp. 155-207 in Surveys of Economic Theory, vol. III, (New York: St. Martin's Press, 1966).

Rainer Schickele, Agrarian Revolution and Economic Progress (New York: Praeger, 1968). Especially pp. 26-42, 73-88, and 365-385.

Morris J. Solomon, Analysis of Projects for Economic Growth (New York: Praeger, 1970), pp. 3-36.

Egbert de Vries, "Bringing Systems Analysis into the Rural World," pp. 37-42 in CERES (FAO Review), vol. 4, no. 1, Jan.-Feb. 1971.

W. Y. Yang, Methods of Farm Management Investigations, FAO Agricultural Development Paper no. 80,(Rome, FAO/UN, 1965), ch. 10, "Cost/Benefit Appraisal of Agricultural and Farm Projects," pp. 229-243.

Some Questions for Thought and Discussion

1) During this course so far, what agricultural projects in your home country (either proposed or already existing) have come especially to mind?

   Tell us about their purposes, the agencies involved, and any problems encountered so far.

2) To what extent have the feasibility and impacts of these projects been analyzed? By whom? At what stage? How well?

3) If these projects have been analyzed, to what extent have officials in your country made use of this in establishing priorities, or deciding whether to implement them?

4) What considerations seem to be uppermost in the minds of officials or political leaders in your country when deciding whether a proposed project is "good" or "bad"?

5) If you have been involved in project analysis, tell us about the procedures and information sources that are used. Are there ways in which you think these could be improved? What to you have been the most difficult or confusing aspects of project analysis?

6) What are some reasons why the same kind of project (for example, a rural electrification scheme) might rightly have very high priority in one country, but low priority in another?

Some Ideas for Teaching Part A

1) This introductory overview might be led off with a snappy, illustrated presentation by the instructor. The main aims would be to a) give perspective about the place of agricultural projects and project analysis in development, and b) preview the key elements of financial and economic analysis.

2) To help "legitimize" the importance of project analysis, an experienced analyst or development official might spend some time with the group to discuss some actual instances where project analysis has and has not been effectively used. He could also explain in some detail the actual steps involved in formulating, analyzing, and implementing a project...perhaps best by tracing the history of an actual project.

3) There could also be one or more discussions by resource people about emerging agricultural development patterns and needs (maybe starting with a world perspective); linkages between agriculture and other sectors; the importance of keeping in mind the responses and attitudes of farmers and others involved; how project analysis can be effectively utilized in the political decision-making arena. (Or such sessions could be interspersed later in the course to provide a change of pace from the more detailed aspects of project analysis.)

4) The group's attention might be called to some of the books and articles that provide good overviews of agricultural development and project analysis without getting too "theoretical." Participants might be especially urged to read pages 1-14 of the book by J. Price Gittinger, Economic Analysis of Agricultural Projects, as well as the summary of his book in the July, 1973, issue of the (AID) Development Digest, pages 3-27.

5) After the initial overview presentation, some or all of the participants might be asked to tell about the projects in their home countries that are particularly on their minds, procedures being used to analyze such projects, problems that have been encountered, and their specific roles. (Instead or in addition, each could be asked to write this information down on a page or two.) This would help the participants begin to relate course content to their home situations. It would also provide the instructor with some guidelines about aspects and applications needing special attention during the remainder of the course.

Part B

Financial Analysis

PART B

CORE ELEMENTS OF PROJECT ANALYSIS— IS IT FINANCIALLY VIABLE FOR THOSE CONCERNED?

Part B focuses on project analysis from the viewpoints of specific parties involved--farmers, lending agencies, and often others. This is what some writers like Gittinger refer to as "financial analysis." Even though a project helps an economy as a whole, it may or may not be beneficial to all persons or organizations affected. And the groups on whom project success depends may or may not be financially able, or have enough incentive, to provide the needed cooperation or response.

A companion aim of Part B is to present the pivotal features of benefit-cost analysis, especially the "discounting" idea and some measures of project returns. These concepts and methods form the backbone of not only "financial analysis," but also the analysis of social economic effects to be covered in Part C.

Key points are...

** *The basic facts needed are year-by-year estimates of changes in benefits and costs brought about by the project (B-2 to B-5).*

** *Undiscounted measures of project returns--Cash Flow, Net Returns Per Dollar Invested, Payback Period, and others--are sometimes used. But they fail to take into account that tying up funds in a project means foregoing returns from other uses (B-6 to B-9).*

** *Even if a project has a high return, farmers or others may not be able to meet the required investments and repayments; changes in project design or financial arrangements may be needed (B-10 and B-11).*

** *"Compounding" is a way to place projects on a more comparable basis; it views benefits and costs from the end of project life-span and reflects the earnings given up when diverting funds from other uses (B-12 and B-13).*

** *"Discounting" is a more commonly used way to assess and compare projects; it too reflects earnings given up from other uses but views benefits and costs from the beginning of project life-span (B-14 to B-17).*

** *When discounting, computational steps can often be saved by using an "annuity factor" or by discounting annual net benefits (B-18 and B-19).*

** *Whereas Net Present Worth measures size of discounted return, Benefit-Cost Ratios and Internal Rate of Return are often used to measure the rate of returns to project outlays (B-20 to B-23).*

** *Which measure(s) to use depends partly on whether projects being compared are mutually exclusive, or are being ranked in order of priority (B-24 and B-25).*

Basic Information Needed for Project Analysis

Though other information may be needed, the heart of project analysis lies in estimates of the changes in costs and benefits that would occur each year during the life of the project. If farmers are the main group affected, such estimates need to be made for representative farm situations If a project manager is involved (such as a co-op or a government agency), projections of its project-related costs and revenues would be needed too. If other groups are involved or affected, (such as lending agencies or private businesses), similar year-by-year information about project impacts on them may be required also.

All the costs and benefits of farms and other project-related groups may not be relevant for project analysis. Those which change as a result of the project are of primary concern. This entails comparing 1) what would happen with the project and 2) what would happen without the project during the same period of years.

A project may cause changes not only in amounts of costs and benefits, but also in sources of costs and benefits. There may be both increases and decreases. For instance, a project may lead to farmers producing a new crop and, thereby, to new kinds of expenses and sales. But this new crop may replace a crop formerly grown for which there will no longer be certain costs and returns.

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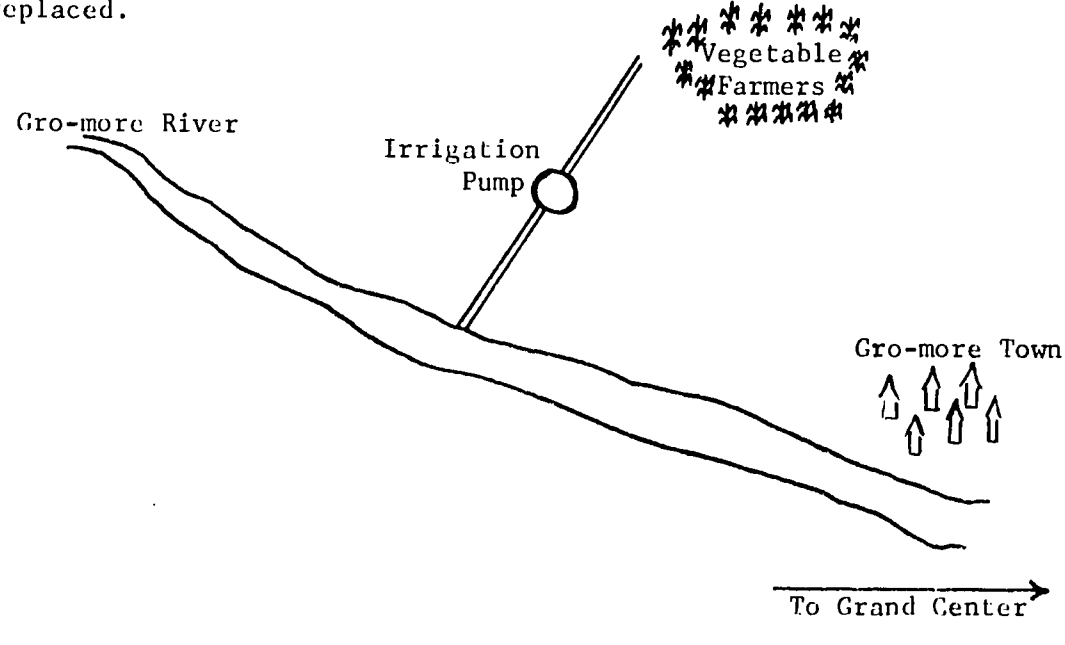
To help explain project analysis, we shall use a make-believe example--a proposal by the Farmers Association in Gro-more situation is depicted on page B-3. The annual changes in costs and benefits that the project would generate for the typical vegetable farmer and for the Farmers Association are summarized on pages B-4 and B-5. More assumptions and information will be incorporated as the explanation proceeds.

THE GRO-MORE EXAMPLE--A PROPOSAL TO PUMP IRRIGATION WATER

The Gro-more River (a relatively small stream) runs through a valley in which there are several hundred small holdings producing a variety of crops and livestock. The produce that they sell is usually marketed in the nearby hamlet, Gro-more Town, which is where they also buy most of their supplies. Much of the produce is shipped by the local buyers to Grand Center, a large city located 60 kms. downstream. In Gro-more Town there is a cooperative farmers association (Gro-more FA) which buys farm products, sells farming supplies, makes production loans, and provides extension help. The FA could provide other services if requested.

Among the small holders in the Valley, there is a cluster of 50 farmers who specialize in vegetable production. Until now they have not used irrigation. It is believed that additional water would significantly increase their output and earnings, but it is not feasible for the individual grower to do this. The manager of the Gro-more FA proposes a project in which irrigation water from the Gro-more River would be pumped to the vegetable farms by pipe.

Under the plan, the FA would buy and operate a central pumping station, as well as the system for bringing the water to each farm. These costs would be covered by a fee charged to the vegetable farmers each year, based on the amount of water used. The individual farmer would be responsible for buying and maintaining the irrigation equipment needed to utilize the water on his farm. It is expected that the irrigation equipment, both the FA's and the farmers', will last five years before needing to be replaced.



ESTIMATED COSTS AND RETURNS: TYPICAL GRO-MORE VEGETABLE FARMER

	Year 1	2	3	4	5	5-Year Total
	dollars					
Without the project						
Costs: usual production expenses	3,000	3,000	3,000	3,000	3,000	15,000
Returns: vegetable sales	5,000	5,000	5,000	5,000	5,000	25,000
Net returns to the grower	2,000	2,000	2,000	2,000	2,000	10,000
With the project						
Costs:						
Usual production expenses	3,000	3,000	3,000	3,000	3,000	15,000
Purchase of irrigation equipment	4,500	--	--	--	--	4,500
Payments to FA for water	400	400	400	400	400	2,000
Extra labor for irrigating	600	600	600	600	600	3,000
Returns: vegetable sales	8,000	8,000	8,000	8,000	8,000	40,000
Net returns to the grower	(500)	4,000	4,000	4,000	4,000	15,500
Changes stemming from the project						
In costs:						
Irrigation equipment	4,500	--	--	--	--	4,500
Water fees	400	400	400	400	400	2,000
Extra labor	600	600	600	600	600	3,000
In returns: added vegetable sales	3,000	3,000	3,000	3,000	3,000	15,000
In net returns to the grower	(2,500)	2,000	2,000	2,000	2,000	5,500

ESTIMATED COSTS AND RETURNS: THE GRO-MORE FARMERS ASSOCIATION

	Year 1	2	3	4	5	5-Year Total
	dollars					
Without the project						
Costs: usual services and sales	60,000	60,000	60,000	60,000	60,000	300,000
Income: from usual services and sales	70,000	70,000	70,000	70,000	70,000	350,000
Net FA income	10,000	10,000	10,000	10,000	10,000	50,000
With the project						
Costs:						
Usual services and sales	60,000	60,000	60,000	60,000	60,000	300,000
Purchase of central pump system	40,000	--	--	--	--	40,000
Operation and maintenance of pump system	8,000	9,000	10,000	11,000	12,000	50,000
Income:						
From usual services and sales	70,000	70,000	70,000	70,000	70,000	350,000
Water fees from the 50 vegetable growers	20,000	20,000	20,000	20,000	20,000	100,000
Net FA income	(18,000)	21,000	20,000	19,000	18,000	60,000
Changes stemming from the project						
In costs:						
Central pump system	40,000	--	--	--	--	40,000
Operation and maintenance of pump system	8,000	9,000	10,000	11,000	12,000	50,000
In income: water fees from the growers	20,000	20,000	20,000	20,000	20,000	100,000
In net FA income	(28,000)	11,000	10,000	9,000	8,000	10,000

Net Benefit and "Ratio" Measures of Project Returns

Several indicators are commonly used to summarize the net returns from, and the productivity of, a project investment over the entire lifetime of the project. They are used also to compare one project with another. Three of these measures are:

NET BENEFIT (or CASH FLOW)

$$= \left[\begin{array}{l}\text{Gross change in returns} \\ \text{stemming from the project.} \\ \text{Sum of all years.}\end{array}\right] - \left[\begin{array}{l}\text{Gross change in costs (investment} \\ \text{and other project-related expense).} \\ \text{Sum of all years}\end{array}\right]$$

NET RETURNS PER DOLLAR OF INVESTMENT

$$= \frac{\text{Gross change in returns - Annual project costs}}{\text{Initial capital investment}}$$

AVERAGE ANNUAL NET RETURNS PER DOLLAR OF INVESTMENT

$$= \frac{\text{Net returns per dollar of investment}}{\text{Project life, in years}}$$

"Net Benefit" and similar measures of project returns provide an estimate of the absolute amount of net gain that a project produces, but they don't tell us how productively the funds tied up in the project are used. Ratio indicators, like "Net Returns per Dollar of Investment" and "Average Annual Net Returns per Dollar of Investment," tell us something about capital use productivity but don't say anything about total amount of net benefit. A project with a high rate of return per dollar spent could be very small and not have much total impact: a project with a large Net Benefit could involve vast amounts of funds from which the rate of return is very low. Often both types of measures are used to compare projects.

How these measures can be applied to the Gro-more example at the farmer and farmers association levels is shown on the opposite page. Similar indicators can be used to summarize economic impacts of projects on the nation as a whole. Additional measures are sometimes used to examine project effects on farmers and other project entities in more detail.

One limitation of the measures illustrated here is that they do not take into account when during a project's time span expenses and returns take place. The longer funds are tied up in a project, the less opportunity there is to use them in other income-producing ways. As will be seen in later sections on "compounding" and "discounting," a more accurate way to assess project effects is to bring these alternative capital uses into the picture.

SOME COMMON MEASURES OF PROJECT RETURNS: TYPICAL GRO-MORE VEGETABLE FARMER

Basic information (from page B-4):

Gross change in returns, 5-year total.....$15,000
Gross change in costs, 5-year total
Investment in irrigation equipment $4,500
Water fees and extra labor $5,000 } .....$ 9,500

Net benefit (cash flow) = $15,000 - $9,500 = $5,500

Net returns per dollar of investment

$$\frac{\$15,000 - \$5,000}{\$4,500} = \frac{\$10,000}{\$4,500} = 222\% \text{ over the 5 years}$$

Average annual net returns per dollar of investment

$$\frac{222\%}{5 \text{ years}} = 44\% \text{ per year}$$

SOME COMMON MEASURES OF PROJECT RETURNS: THE GRO-MORE FARMERS ASSOCIATION

Basic information (from page B-5):

Gross change in returns (water fees), 5-year total.....$100,000
Gross change in costs, 5-year total
Investment in central pump system $40,000
Operation and maintenance $50,000 } .....$ 90,000

Net benefit (cash flow) = $100,000 - $90,000 = $10,000

Net returns per dollar of investment

$$\frac{\$100,000 - \$50,000}{\$40,000} = \frac{\$50,000}{\$40,000} = 125\% \text{ over the 5 years}$$

Average annual net returns per dollar of investment

$$\frac{125\%}{5 \text{ years}} = 25\% \text{ per year}$$

Another Measure of Project Return: Payback Period

Another indicator of project return is "Payback Period"--the number of years needed for gains in net operating income to pay for the capital investment in the project. This entails calculating for each project year:

1) Gains in net operating income = [Added gross income] - [Added costs, excluding initial capital investment]

2) Cumulative gains in net operating income = [Sum of gains in net operating income for the preceding years]

3) Unpaid balance of the initial capital investment = [Initial capital investment] - [Cumulative gains in net operating income]

Often the payback period will not coincide exactly with the end of a project year; it may be sometime between one year and the next. The fraction of the final year needed to recover the remaining balance can be calculated as:

[Unpaid balance of the initial capital investment] ÷ [Gain in net operating income during the final "repayment" year]

Payback period is sometimes used as a performance index in situations where future events are quite uncertain and there is concern that project investments pay for themselves as quickly as possible. But it fails to take into account what would happen after the payback period. An investment could be recovered rapidly, yet show poor results during the remaining project years. Benefits from another project with the same payback period could tend to "blossom out" during subsequent years.

As with the "ratio" measures (see page B-6), payback period does not distinguish between large and small projects. A project could have a short payback period, but be insignificant in terms of scale or magnitude of net benefits.

PAYBACK PERIOD: TYPICAL GRO-MORE VEGETABLE FARMER

	Dollars at End of Year: 1	2	3	4	5
Investment in irrigation equipment	4,500				
Changes in:					
Income (vegetable sales)	3,000	3,000	3,000	3,000	3,000
Operating costs (extra labor + water fees)	1,000	1,000	1,000	1,000	1,000
Net operating income	2,000	2,000	2,000	2,000	2,000
Cumulative changes in net operating income	2,000	4,000	6,000	8,000	10,000
Unpaid balance of investment in irrigation equipment	2,500	500	--	--	--

Payback period is between 2 and 3 years
or, more precisely,

$$2 \text{ years} + \frac{\$500}{\$2,000} = 2.25 \text{ years}$$

PAYBACK PERIOD: THE GRO-MORE FARMERS ASSOCIATION

	Dollars at End of Year: 1	2	3	4	5
Investment in central pump system	40,000				
Changes in:					
Income (water fees)	20,000	20,000	20,000	20,000	20,000
Operating costs (pump)	8,000	9,000	10,000	11,000	12,000
Net operating income	12,000	11,000	10,000	9,000	8,000
Cumulative changes in net operating income	12,000	23,000	33,000	42,000	50,000
Unpaid balance of investment in central pump system	28,000	17,000	7,000	--	--

Payback period is between 3 and 4 years
or, more precisely,

$$3 \text{ years} + \frac{\$7,000}{\$9,000} = 3.78 \text{ years}$$

Financial Capability: Can Funding Needs Be Met?

So far, we have dealt with the payoffs of projects to farmers and others. But this is only one facet of project feasibility. A second important consideration is those involved are financially able to go ahead with the undertaking as proposed.

Projects usually entail an initial capital investment, plus annual costs that otherwise would not be incurred. Sometimes (though not in our Gro-more example) it takes several years before project benefits show up. Groups who participate in a project (small farmers especially) may not have enough money to pay for the initial investment or to tide themselves over until the project pays off. Project proposals may have to be revised, or credit provisions liberalized, to overcome such problems.

Analysis of projects from this viewpoint requires three additional kinds of information:

1) Inventory of financial position (assets, liabilities, cash reserves) of the project entity prior to the project.

2) Other (nonproject) earnings and obligations of that entity incurred during the project lifespan.

3) Possible sources of credit for the undertaking, interest charges, and repayment schedules.

This information will help answer the following kinds of questions:

** Does the [farmer] have enough money to pay for the initial investment?

** Will the [farmer] have enough net earnings from all sources during the early years to meet annual project costs as well as to support himself?

** If credit is needed to help with initial investment or annual costs, how would the [farmer's] net benefits be affected by the interest charges incurred?

** Does the repayment schedule for such credit mesh well with the [farmer's] anticipated time flow of costs and returns?

Even if his financial reserves are adequate to cover project needs, it may still be productive for a [farmer] to borrow funds for this: his own money could have other uses that are more profitable.

THE GRO-MORE VEGETABLE FARMER: WHAT IF HE HASN'T ENOUGH MONEY?

The Gro-more example, as presented thus far (see page B-4), has tacitly assumed that the typical farmer would have enough cash reserves to buy the irrigation equipment--that is, at least $4,500. But what if he doesn't? What if he has no savings prior to the project, but could borrow money at 10% annual interest from the local Agricultural Bank for this initial investment?

If the Bank asks him to repay principal and interest in equal installments each of the five project years, the picture would be as follows:

	Year 1	2	3	4	5	5-Year Total
	----------dollars----------					
Added income:						
Loan to buy irrigation equipment	4,500					4,500
Gains in vegetable sales	3,000	3,000	3,000	3,000	3,000	15,000
Added costs:						
Purchase of irrigation equipment	4,500					4,500
Water fees to the FA	400	400	400	400	400	2,000
Extra labor for irrigating	600	600	600	600	600	3,000
Repayment of principle and interest to the Bank*	1,187	1,187	1,187	1,187	1,187	5,935
Net benefits to the farmer	813	813	813	813	813	4,065

*Calculated from the "capital recovery factor" @ 10% interest for five years. See David J. Neebe and John D. Hyslop, Compound Interest and Discount Factor Tables for Use in Capital Analysis, April, 1971, page 23.

$.2638 would be required each of the five years to repay principal plus interest for a $1.00 loan, so $1,187 annually would be needed to repay the loan of $4,500.

Total interest payments for the $4,500 loan would be $1,435, thereby reducing project net benefits to the farmer by that amount. In this instance there is no need of loans for family support during the early years of the project. Sometimes, where there are added annual costs but no project returns at first, this is a problem.

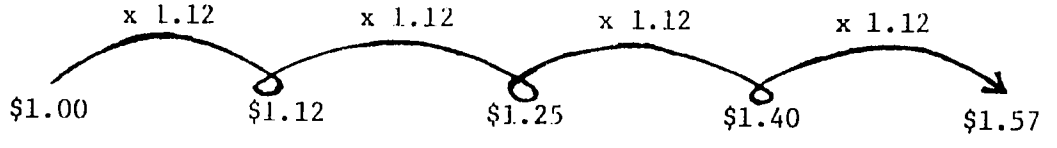
Taking into Account Investment Opportunities Over Time: Compounding

The measures of net project returns discussed earlier (pages B-6 to B-9) overlook something. They fail to consider that investing in a project means tying up funds that might have been used to earn income somewhere else. And they fail to consider that project returns could be reinvested to produce still more income during the remainder of the project period.

Explained another way, which would you rather have: $1,000 income this year, or $1,000 five years from now? Undoubtedly this year, for you could use or reinvest it sooner. And for the same return 10 years from now, which would you prefer: a project that requires investing $500 now, or one that doesn't need the investment until three years from now? Probably the latter project, for you could keep these funds in savings or other investments during the first three years. The earlier a project pays off, the sooner one can use that income in other productive ways; the longer money is tied up in a project, the less time there is to invest it elsewhere. That is, funds have an "opportunity cost."

So simply adding up the actual costs and benefits of a project doesn't tell the whole story. The total income generated and foregone during the project life-span, including potential earnings from other investment opportunities, needs to be incorporated. Two projects could have the same net cash benefits, yet be quite different as to <u>when</u> funds are tied up or income earned.

A procedure called "compounding" can be used to help trace these project impacts on total investment earnings out to the end of the project period. For instance, a dollar of project income reinvested now at 12% (compounded annually) would become $1.57 in four years"



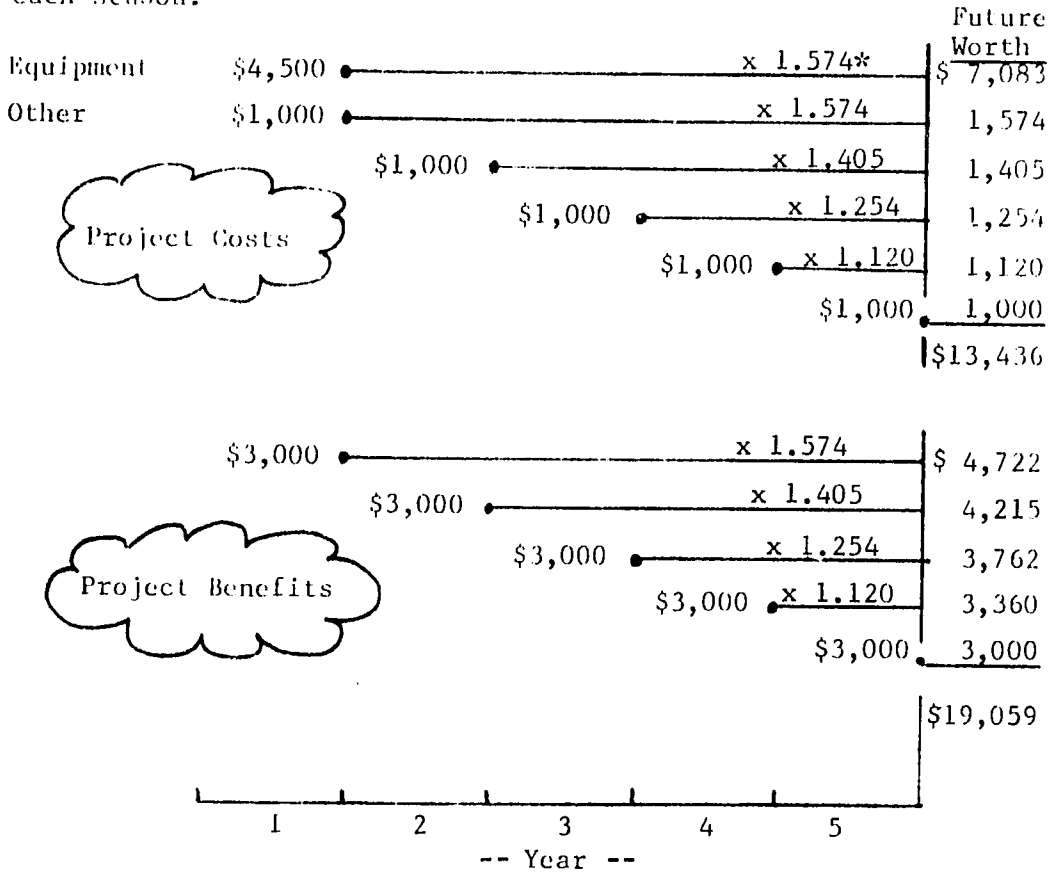
Compound interest tables (see the left-hand columns in the Neebe-Hyslop set of tables) provide a convenient way to determine how much money earned or spent now would be worth at the end of ____ years, if invested at ____ rate of interest.

How this can be applied to estimation of the "future worth" of project costs and benefits is illustrated on page B-13 for the Gro-more farmer situation. As viewed from the end of the five-year period, the net gains to the Gro-more farmer become $5,623, as against $5,500 when his opportunity to earn bank interest is not taken into account. Similar "compounding" analysis would be appropriate for the Gro-more Farmers Association if it too had alternative ways to invest its funds.

COMPOUNDING OF COSTS AND BENEFITS: TYPICAL GRO-MORE VEGETABLE FARMER

Suppose that the Gro-more vegetable farmer can earn 12% per year by investing his money in a local savings bank. If he draws on these savings to pay for irrigation equipment and other project costs, he will lose interest on those amounts. But he can also deposit the extra income from the irrigation project and earn additional interest on those amounts.

How much will project costs and benefits be worth at the end of the five-year project period if this savings opportunity is taken into account? This can be determined by "compounding" the farmer's cash outlays and returns (see page B-4) through the remainder of the five years, as depicted below. We assume here that the farmer "settles up" with those he buys from, and sells to, at the end of each season.

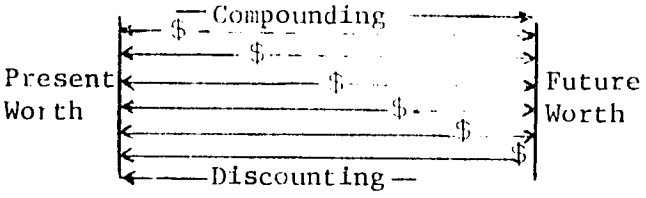


Net future worth of the project to the farmer = $19,059 - $13,436 = $5,623.

*Compounding factor for $1.00 @ 12%. See the Neebe-Hyslop tables, page 26.

Another Way to Take Other Investments into Account: Discounting

Compounding tells us what the stream of project costs and benefits would be worth at some future point in time (usually the end of the project lifetime) if reinvestment possibilities are considered. An alternative way to put projects on a comparable basis is to "discount" the flow of annual costs and benefits back to the present--that is, back to the point in time when the project begins. When we discount project costs, we are asking: "How much would we have to set aside now at ____ rate of interest to have enough funds for project costs when they are incurred?" When we discount project benefits, we are asking: "How much would we have to invest now at ____ rate of interest to be equal to the returns from the project when they are produced?"



The present value of project costs and benefits can be calculated with the help of the "discount factor." (See column 1 on the right-hand pages of the Neebe-Hyslop set of tables.) Discount factors show the present worth of a dollar spent or received at various times in the future under various interest rates.

Both compounding and discounting add two features to project analysis: 1) they bring returns given up from other, non-project investment possibilities into the picture, and 2) they convert cost and returns flows into their equivalent at a single point in time. For comparing project proposals, either compounding or discounting will give the same results. The only difference is that compounding views things from an after-project perspective, whereas discounting provides a before-project perspective.

In practice, most project analysis use discounting rather than compounding (partly because the numbers involved are smaller). So in the remainder of this manual we too shall use discounting. How this can be applied to determine "net present worth" for the Gro-more farmer and Farmer Association situations is illustrated on pages B-15 and B-16. The same examples, arranged in a more conventional table format, are shown on page B-17.

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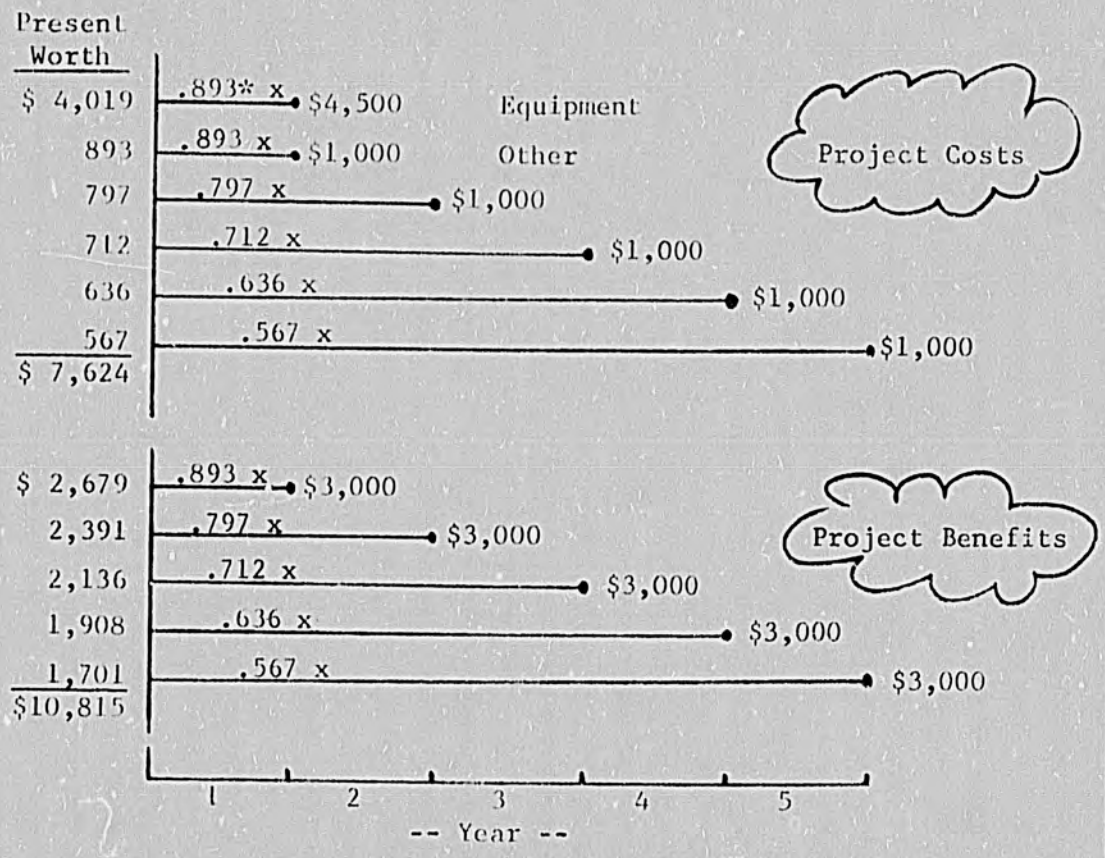
Note that the appropriate interest rate to use in both compounding and discounting is the best rate that could be earned in investment possibilities outside the project. This will not necessarily be the same as the interest rate at which funds for the project can be borrowed.

DISCOUNTING AND NET PRESENT WORTH: TYPICAL GRO-MORE VEGETABLE FARMER

Suppose that, as in the compounding example (page B-13), the Gro-more vegetable farmer can earn 12% per year from funds invested in the local savings bank. He can keep funds in the bank until needed for the irrigation project and can reinvest project returns there also.

How much will project costs and benefits be worth at the beginning of the project period if this savings opportunity is taken into account? This can be determined by "discounting" the farmer's cash outlays and returns (see page B-4) back to the present, as shown below. Here again, we assume that the farmer settles his accounts with others at the end of each season.



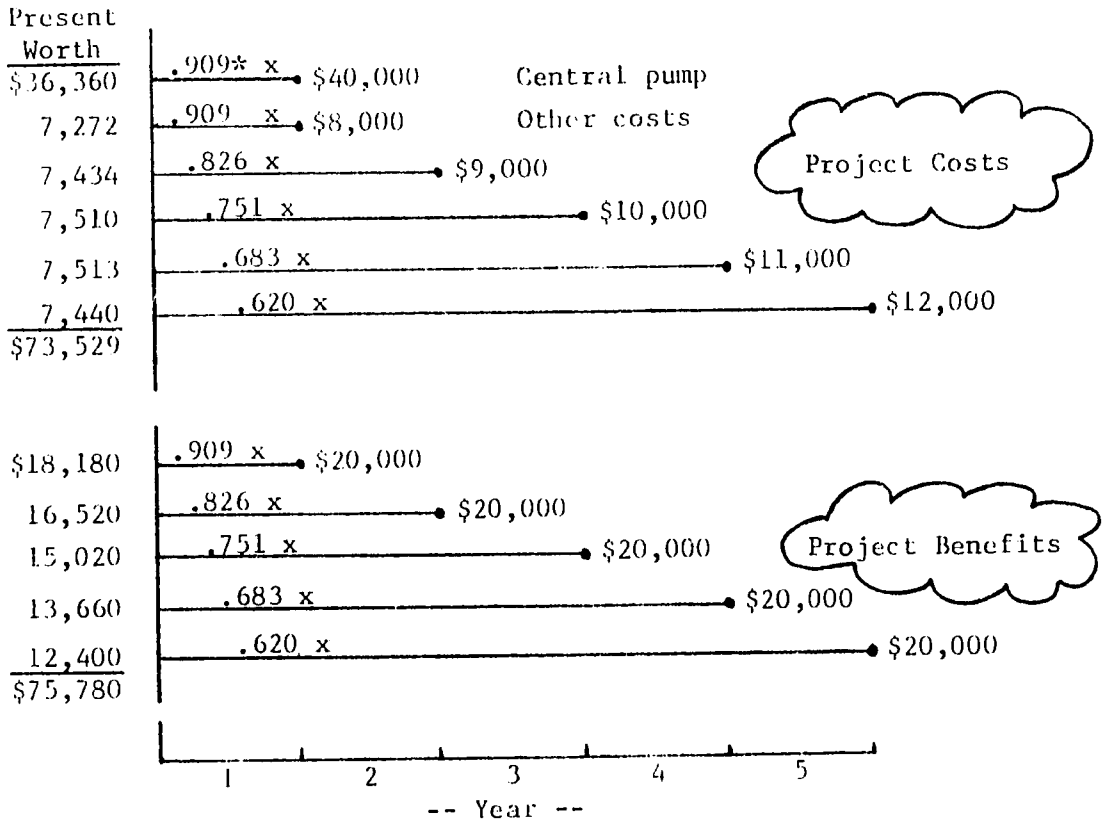
Net present worth of the project to the farmer = $10,815 - $7,624 = $3,191.

*Discount factor for $1.00 @ 12%. See the Neebe-Hyslop tables, page 27.

DISCOUNTING AND NET PRESENT WORTH: THE GRO-MORE FARMERS ASSOCIATION

Suppose that the Gro-more FA is using its surplus funds to operate a side venture--a retail store to sell household appliances to local people. It is earning an annual return of 10% from its investments in this.

How much will the benefits and costs of the irrigation project (see page B-5) be worth at the beginning of the period if this other FA investment outlet is considered? Here again, discounting can be used to determine the project's present worth.



Net present worth of the project to the FA = $75,780 - $73,529 = $2,251.

*Discount factor for $1.00 @ 10%. See the Neebe-Hyslop tables, page 23.

PRESENT WORTH CALCULATIONS IN TABLE FORM: TYPICAL GRO-MORE FARMER

The discounting procedure for determining present worth to the farmer (page B-15) can also be shown in the following table form. This is the more common format for presenting such analysis, as it lends itself to projects involving a large number of years.

	Project Costs			Gross	Discount	Present Worth	
Year	Invest-ment	Other	Gross	Project Benefits	Factor, 12%	Gross Costs	Gross Benefits
1	$4,500	$1,000	$5,500	$ 3,000	.893	$4,912	$ 2,679
2	--	1,000	1,000	3,000	.797	797	2,391
3	--	1,000	1,000	3,000	.712	712	2,136
4	--	1,000	1,000	3,000	.636	636	1,908
5	--	1,000	1,000	3,000	.567	567	1,701
Total	$4,500	$5,000	$9,500	$15,000		$7,624	$10,815

Net present worth @ 12% = $10,815 - $7,624 = $3,191 to the farmer.

PRESENT WORTH CALCULATIONS IN TABLE FORM: THE GRO-MORE FA

Likewise, the discounting calculations for the Gro-more FA (page B-16) can be shown in table form:

	Project Costs			Gross	Discount	Present Worth	
Year	Invest-ment	Other	Gross	Project Benefits	Factor, 10%	Gross Costs	Gross Benefits
1	$40,000	$ 8,000	$48,000	$ 20,000	.909	$43,632	$13,180
2	--	9,000	9,000	20,000	.826	7,434	16,520
3	--	10,000	10,000	20,000	.751	7,510	15,020
4	--	11,000	11,000	20,000	.683	7,513	13,660
5	--	12,000	12,000	20,000	.620	7,440	12,400
Total	$40,000	$50,000	$90,000	$100,000		$73,529	$75,780

Net present worth @ 10% = $75,780 - $73,529 = $2,251 to the FA.

Two Shortcuts for Computing Present Worth

For projects that last many years, the discounting methods explained on the preceding pages can become tedious. Computational work can often be reduced by using either or both of two shortcuts:

1. Using an "annuity factor," instead of calculating present worths of costs or benefits for each year separately with discount factors. (See middle column of the right-hand pages of the Neebee-Hyslop tables for annuity-discount factors.)

   An annuity-discount factor tells us how much a dollar spent or forthcoming each of ____ years in the future would be worth today at ____% interest. This can be used for annual project costs or benefits that are the same over a period of years. (See the upper example on page B-19.) Annuity factors cannot readily be used for benefit or cost components that vary from year to year.

   For further explanation of the annuity-discount factor and its uses, see pages 132-133 in the World Bank/EDI Compounding and Discount Tables for Project Evaluation, 1973.

2. Computing annual net benefits before discounting. By subtracting each year's project costs from project benefits, one then has only to discount the resulting annual net benefits back to the present. This saves discounting costs and benefits separately. The overall Net Present Worth is exactly the same. (See the lower example on page B-19.)

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The same shortcuts can be applies to computation of future growth (compounding). There is an annuity-compounding factor, which tells us the compounded value of a dollar spent or forthcoming at the end of every year for ____ years at ____% interest. (See the middle column of the left-hand pages of the Neebe-Hyslop tables.) And, as with discounting, annual net benefits can be used to compute net future worth, rather than compounding gross benefits and costs separately.

DISCOUNTING WITH AN ANNUITY FACTOR: TYPICAL GRO-MORE VEGETABLE FARMER

The annuity-discount factor can be used to discount both project benefits (added vegetable sales) and annual costs (water fees and added labor) of the Gro-more vegetable farmer, since they are the same from year to year. The regular discount factor would still be used to determine present worth of his investment in irrigation equipment, as it occurs only once.

Annual benefit	x Annuity-discount factor =	Present worth of the 5-years' benefits
$3,000	3.605*	$10,815
Annual cost	x Annuity-discount factor =	Present worth of the 5-years' costs
$1,000	3.605*	$3,605
Investment cost	x Regular discount factor =	Present worth of investment cost
$4,500	.893	$4,019

Net present worth = $10,815 - [$3,605 + $4,019] = $3,191

*Present worth of $1.00 received at the end of each of 5 years @ 12% interest. See the Neebe-Hyslop tables, page 27.

In the Gro-more FA situation, the annuity-discount factor could be used to compute present worth of project benefits, but not for annual costs since they differ each year.

DISCOUNTING ANNUAL NET BENEFITS: TYPICAL GRO-MORE VEGETABLE FARMER

Year	Gross Project Benefits	Gross Project Costs	Net Project Benefits	Discount Factor, 12%	Net Present Worth
1	$3,000	$5,500	($2,500)	.893	($2,233)
2	3,000	1,000	2,000	.797	1,594
3	3,000	1,000	2,000	.712	1,424
4	3,000	1,000	2,000	.636	1,272
5	3,000	1,000	2,000	.567	1,134
		Net present worth for the 5 years			3,191

The annuity-discount factor can be used in conjunction with discounting of net benefits if desired. In this example, one would first compute present worth of annual net benefits, excluding investment [$2,000 x 3.605 = $7,210], and then deduct present worth of the initial investment [$4,500 x .893 = $4,019].

Benefit-Cost Ratios

The measure of discounted project returns used in the preceding pages--"Net Present Worth"--provides an indication of amount. But it does not say anything about the rate of return to project funds used. One project having a higher Net Present Worth than another wouldn't necessarily mean that it uses funds more efficiently; it could simply be that one project is larger than the other.

A commonly used indicator of project productivity is the "Benefit-Cost Ratio." When all project-related benefits and costs are included, it is calculated as:

$$\frac{\text{Present worth of gross benefits}}{\text{Present worth of gross costs}} \quad \text{. . .which we shall call } BCR_{all}$$

Sometimes annual production and/or maintenance costs are excluded, so as to place sharper focus on payoffs to the project investment itself. When all annual costs are left out, the benefit-cost calculation would be:

$$\frac{\text{Present worth of [gross benefits, less annual project costs]}}{\text{Present worth of initial investment cost}} \quad \text{. . .which we shall call } BCR_{inv}$$

Agencies vary as to the "grossness" of benefits and costs included in their Benefit-Cost Ratio calculations. BCR_{all} will tend to be lower than BCR_{inv}. This is because project "profits" are divided into a smaller cost base. So when using Benefit-Cost Ratios to make comparisons, one has to be careful that the cost basis is consistent from one project to another.

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Some projects may have a Net Present Worth that is negative (discounted costs exceed discounted benefits). Accordingly, the Benefit-Cost Ratio will be less than 1.0. How does one interpret this? What this says is that income would be sacrificed by tying up funds in the project. It would earn a lower rate of return than the interest rate used to discount benefits and costs. The farmer could earn more by putting his money to use in other ways. (Of course, there may be other, nonincome considerations that still lead one to decide to go ahead with such projects.)

BENEFIT-COST RATIOS: TYPICAL GRO-MORE VEGETABLE FARMER

We can calculate benefit-cost ratios for the Gro-more farmer from the discounted cash flow information on page B-15 or B-17.

$$BCR_{all} = \frac{\text{Present worth of gross benefits}}{\text{Present worth of gross costs}} = \frac{\$10,815}{\$7,624} = 1.42$$

$$BCR_{inv} = \frac{\text{Present worth of [gross benefits, less recurring project costs]}}{\text{Present worth of project investment cost}}$$

$$= \frac{3.605\ [\$3,000 - \$1,000]}{.893\ [\$4,500]} = \frac{\$7,210}{\$4,019} = 1.79$$

where 3.605 is the annuity-discount factor for 5 years @ 12%, and .893 is the regular discount factor for 1 year @ 12%.

BENEFIT-COST RATIOS: THE GRO-MORE FARMERS ASSOCIATION

We can calculate benefit-cost ratios for the Gro-more FA from the discounted cash flow information on page B-16 or B-17.

$$BCR_{all} = \frac{\text{Present worth of gross benefits}}{\text{Present worth of gross costs}} = \frac{\$75,780}{\$73,529} = 1.03$$

$$BCR_{inv} = \frac{\text{Present worth of [gross benefits, less recurring project costs]}}{\text{Present worth of project investment cost}}$$

$$= \frac{\left(\begin{array}{l} .909\ [\$20,000 - \$8,000] \\ +\ .826\ [\$20,000 - \$9,000] \\ +\ .751\ [\$20,000 - \$10,000] \\ +\ .683\ [\$20,000 - \$11,000] \\ +\ .620\ [\$20,000 - \$12,000] \end{array}\right)}{.909\ [\$40,000]} = \frac{\$38,611}{\$36,360} = 1.06$$

where the regular discount factors @ 10% are used.

Another Measure of Performance: Internal Rate of Return

"Internal Rate of Return" (IRR) is another commonly used indicator of returns to project outlays. It uses the same discounting procedure that we have used already, except it turns things around. Instead of focusing on project worth, given a certain interest rate, it answers the question: what is the net payoff of the project in terms of percent return on the outlays involved?

Determining the Internal Rate of Return is a trial-and-error process. Net Present Worths (discounted benefits and costs) are calculated at various discount rates. The Internal Rate of Return will be the interest rate at which the Net Present Worth of the project is just equal to zero.

To compute Net Present Worths for all possible discount rates would be too time-consuming. So normally what one does is "zero in" on the rate of return by i) guessing at the relevant range of interest rates (say, 20 to 40%) and then ii) discounting at intervals of, say 5% to find out which rates are too high and too low.

Having "bracketed" the approximate rate of return, one can then determine more precisely what it is by discounting at still closer intervals. For example, if we discount at 25% and Net Present Worth is positive (BCR > 1.0), we know that the Internal Rate of Return is more than 25%. If we then discount at 30% and the Net Present Worth is negative (BCR < 1.0), we know that the Internal Rate of Return is less than 30%.

Even so, the interest rate where Net Present Worth exactly equals zero will usually fall in between two rates for which discounting has been done. If one wants to be more precise, he can go a step further and "interpolate." This is demonstrated in the Gro-more examples on the opposite page. Normally there is no need to compute rate of return beyond the nearest full percentage.

Like Benefit-Cost Ratios, Internal Rate of Return is a ratio estimator. It too is an indicator of capital productivity, but does not distinguish between large and small projects. Especially where it is a matter of choosing one project instead of another (rather than just an order of priorities), rate of return is used in conjunction with a "size" measure, such as Net Present Worth.

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There are ways to "zero in" on the Internal Rate of Return without relying entirely on guesswork or doing lots of discounting. For more about this, as well as the final "interpolation," see pages 76-81 in J. Price Gittinger, Economic Analysis of Agricultural Projects.

INTERNAL RATE OF RETURN: TYPICAL GRO-MORE VEGETABLE FARMER

From the net present worth and benefit-cost ratios calculated earlier, we can see that the internal rate of return to the farmer's outlays in the irrigation project would be much higher than 12%. So, trying progressively higher discount rates, we find that the internal rate of return is something between 70 and 75%. Since our Neebe-Hyslop tables go to only 50%, in this instance we have to compute our own discount factors, using the formula: $1/[1 + i]^n$.

Year	Gross Benefits	Gross Costs	Net Benefits	Discount Factor @ 70%	Present Worth @ 70%	Discount Factor @ 75%	Present Worth @ 75%
1	$3,000	$5,500	$(2,500)	.588	$(1,470)	.571	$(1,428)
2	3,000	1,000	2,000	.346	692	.327	654
3	3,000	1,000	2,000	.204	408	.187	374
4	3,000	1,000	2,000	.120	240	.107	214
5	3,000	1,000	2,000	.070	140	.061	122
	5-year net present worth				10		(64)

Difference is $74

Interpolating between 70 and 75%, we ask: $74 is what portion of this difference? [$10/$75 = .135]

Therefore, the rate of return is about 14/100 of the way between 70 and 75%, or 70.7 - a very high rate of return indeed!

INTERNAL RATE OF RETURN: THE GRO-MORE FARMERS ASSOCIATION

From our previous outlays calculations, we can see that the internal rate of return to the FA's outlays in the project is not much greater than the discount rate already used, 10%. First we try 15%. This is too high, as net present worth is less than 0. So then we try 14%. This is too low, since net present worth is greater than 0. Interpolating between 14 and 15%, the more precise rate of return is 14.3%.

Year	Gross Benefits	Gross Costs	Net Benefits	Discount Factor @ 15%	Present Worth @ 15%	Discount Factor @ 14%	Present Worth @ 14%
1	$20,000	$48,000	$(28,000)	.870	$(24,360)	.877	$(24,556)
2	20,000	9,000	11,000	.756	8,316	.769	8,459
3	20,000	10,000	10,000	.658	6,580	.675	6,750
4	20,000	11,000	9,000	.572	5,148	.592	5,328
5	20,000	12,000	8,000	.497	3,976	.519	4,152
	5-year net present worth				(340)		133

Difference is $473

$133 is 133/473 or .28 of this difference.

Therefore, the rate of return is about 28/100 of the way between 14 and 15%, or 14.3%.

Using Discounting Methods to Compare Two or More Projects

We have explained three "discount" measures of project returns--Net Present Worth, Benefit-Cost Ratios, and Internal Rate of Return. One use is to help farmers or other entities answer the question: Will the project have a high enough payoff to make it worthwhile? The answer will usually be "yes" if Net Present Worth is greater than 0, or if the Benefit-Cost Ratio is greater than 1.0, or if the Internal Rate of Return is greater than the rate which project funds could earn elsewhere.

Even if the project is worthwhile in its own right, it still may not make sense to go ahead with it. There may be other proposed projects which have even higher payoffs. Two kinds of situations may exist:

a) Either-or ("mutually exclusive") situations, where one project is to be chosen instead of others. (For instance, sprinkler irrigation instead of a gravity-flow system; a big irrigation project instead of a little one; irrigating now instead of waiting until later.)

b) Ranking situations, where more than one project may be implemented but where funds are limited and order of priority is needed. (For instance, ranking of capital improvements for farmers to make; ranking of new services for a co-op to offer; selection of localities to receive agricultural bank help.)

In either-or situations, it will usually be best to use Net Present Worth, or a similar "size" measure, to compare the alternatives. This tells us which option will yield the most added income. However, if two or more proposals show similar Net Present Worths, "ratio" measures like Benefit-Cost Ratios or Internal Rate of Return can sometimes help sort these out.

In ranking situations, Benefit-Cost Ratios, Internal Rate of Return or other "ratio" measures are most helpful. Some proposals may be small and add relatively little to total income, yet be high yielding investments that merit being included among those having high priority.

For more about project comparison, see J. Price Gittinger, Economic Analysis of Agricultural Projects, pages 91-92 and 110-128.

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Earlier we said that discounting, by taking other ways to use funds account and viewing project effects from a common point in time, helps place projects on a comparable basis. See the Gro-more example on page B-25 for an illustration of how discounting and not discounting can give quite different comparisons.

HOW DISCOUNTING CAN AFFECT PROJECT COMPARISONS: TYPICAL GRO-MORE VEGETABLE FARMER

Suppose that, as an alternative to the irrigation proposal, the Gro-more Farmers Association is thinking of hiring a contractor to spray the farmers' fields several times each year to protect their vegetable crops against insects and diseases. (The vegetable farmers have not been using any pest control measures in the past.) Each farmer would have to pay the FA $1,000 a year to cover the costs of pesticides and the contractor. In this pest control proposal, the gains in vegetable production on each farm would be worth $2,000 a year.

As viewed by the typical farmer, cash flows and discounted benefits and costs for the two alternatives would be as follows:

Year	Gross Benefits	Gross Costs	Discount Factor @ 12%	Present Worth of Benefits	Present Worth of Costs
Irrigation project:					
1	$ 3,000	$5,500	.893	$ 2,679	$4,912
2	3,000	1,000	.797	2,391	797
3	3,000	1,000	.712	2,136	712
4	3,000	1,000	.636	1,908	636
5	3,000	1,000	.567	1,701	567
	$15,000	$9,500		$10,815	$7,624
Pest control project:					
1	$ 2,000	$1,000	.893	$ 1,786	$ 893
2	2,000	1,000	.797	1,594	797
3	2,000	1,000	.712	1,424	712
4	2,000	1,000	.636	1,272	636
5	2,000	1,000	.567	1,134	567
	$10,000	$5,000		$ 7,210	$3,605

And some measures for comparing the two projects would be:

	Irrigation Project	Pest Control Project
Net cash gain	$15,000 - $9,500 = $5,500	$10,000 - $5,000 = $5,000
Net present worth	$10,815 - $7,624 = $3,191	$7,210 - $3,605 = $3,605
Benefit-cost ratio (BCR_{all})	$\frac{\$10,815}{\$7,624} = 1.4$	$\frac{\$7,210}{\$3,605} = 2.0$

Thus we see that, when only cash flows are considered, the pest control project would appear less favorable to the farmer than the irrigation project. However, when the opportunity cost of the farmer's funds is considered (earning 12% in the savings bank), the pest control project shows a larger return, as seen by the net present worth and benefit-cost ratio. This is because the irrigation project requires a considerable amount to be tied up at the beginning, whereas the pest control project does not.

Some Questions for Thought and Discussion

1) It was stressed that the relevant benefits and costs for project analysis are the differences between what would happen with and without the project during the same time span. Isn't this simply the same as comparing benefits and costs before and after the project would be implemented? Why or why not?

2) In the Gro-more example, suppose that going ahead with the irrigation project meant that the Farmers Association had to divert staff and funds from another facet of its operations, thereby reducing earnings from that other facet. Would this affect benefits and costs of the irrigation project? If so, how?

3) Explain in your own words why it is that cash flows (undiscounted net benefits) will not provide a "fair" basis for comparing two or more projects that have a life-span of several years.

4) What measures of project performance are used in your country to compare proposals and establish priorities? How appropriate are these measures? Can you think of others that should be used in addition or instead?

5) Is discounting used in your country in connection with project analysis? If so, what discount rates are used, and how are these particular rates chosen?

6) In the Gro-more example, we used different discount rates for farmers and the Farmers Association (12% and 10%, respectively). Is this a proper thing to do when analyzing projects from specific entities' viewpoints?

7) How adequately do agencies in your country take farmers' financial limitations into account when planning loan and repayment provisions of new projects?

8) When analyzing the income effects of a project on farmers or other entities, only those changes in costs and returns related to the project are important. But when analyzing a project to find out whether such groups are financially able to participate, all of their costs and returns, as well as their available assets, need to be considered. Explain why this is so.

9) Unlike frequent accounting procedures, capital depreciation schedules are not normally used when analyzing project benefits and costs; investments and other costs are counted when actually incurred. Explain why this is done.

10) Suppose that two projects--one requiring a large initial investment, and the other only recurring annual costs--are being compared using discounting procedures. If both projects now have the same net present worth, which project would probably be better if:

a) a higher discount rate were used?

b) a longer period of time into the future was taken into account?

11) In the Gro-more example, suppose that the Farmers Association could sell its old pump system for a salvage price of $5,000 at the end of five years. Show how this would be taken into account when computing net present worth.

12) Explain why, when comparing two projects, it is desirable to calculate benefits and costs over the same time period (for example, 20 years) for both.

13) For which situation is it more important to discount benefits and costs--a project that will last only two years? or a project that will last 15 years?

14) For the Gro-more farmer situation where he has to borrow money to pay for the irrigation equipment (page B-11), show how this would affect net present worth and the benefit-cost ratio (BCR_{all}).

15) In the Gro-more example, as in much project analysis, project costs of the farmer and the Farmers Association were assumed to be incurred the <u>end</u> of each year. But suppose it is more realistic to assume that project investment and annual costs come at the <u>beginning</u> of these years. Show how this would be handled in the discounting procedure.

16) For one or more projects that you have been associated with, who are the specific individuals or groups most directly affected? Has adequate attention been given to effects on them when formulating and analyzing such projects?

Practice Exercise

Suppose that a produce dealer comes to the 50 Gro-more vegetable growers with a proposition. He says there is a new craze in Grand Center for ding berries, an exotic fruit. He proposes a "project" in which, if all the growers would shift from vegetables to berry production and sell the berries to him, he would guarantee them a market. The Gro-more FA would not be involved.

The growers figure that it would take an initial investment of $10,000 each to buy and establish the berry plants. The plants would need replacing after 10 years. Starting the second year, the typical grower would have an annual outlay of $4,000 for labor, pesticides, fertilizer, and other production items. He can expect no berry sales the first year, sales of $3,000 in year 2, $7,000 in year 3, $10,000 annually in years 4 through 9, and $5,000 in year 10. Also, the opportunity cost situation has changed; funds in the savings bank will now earn only 9%.

1) Assuming he has enough funds to meet costs, how would the typical grower fare during the 10 years, relative to continuing with unirrigated vegetables, if he shifted to berries? Calculate the following: a) Cash Flow, b) Net Returns Per Dollar of Investment, c) Average Annual Net Returns Per Dollar of Investment, d) Payback Period, e) Net Future Worth, f) Net Present Worth, g) Benefit-Cost Ratios (BCR_{all} and BCR_{inv}), h) Internal Rate of Return, and i) any other measures that your agency has used or thought about.

2) But what if the typical grower doesn't have any savings to pay for the initial establishment of the berries? And how would his family meet living expenses before the berries come into full production? Assuming that the grower has no other income sources and that his family needs $1,500 a year to live on, determine how much he will have to borrow and when.

3) The growers can borrow this money as needed from the Agricultural Bank, still at 10%, and repayable anytime within the 10 years. But suppose the dealer says, "Look, I'll lend each of you $15,000 the first year. Then, starting the fourth year, you pay me back in seven annual installments of $4,500." Which would be better?

4) Using whichever credit source is better, ascertain what the typical grower's Cash Flow, Net Present Worth, BCR_{all}, and Internal Rate of Return would then be.

5) Using the measures you believe most appropriate (and assuming the no-borrowing situation) compare returns to the grower under the berry proposal against the vegetable irrigation proposal (see B-4).

Some Ideas for Teaching Part B

1) Probably Part B can best be taught in three or four sessions, each covering only two or three key points. Each session could be led off by a concise explanation, using an overhead projector and/or other visual aids, and illustrating with the Gro-more or another simple example. Participants should be encouraged to ask about unclear points and the instructor should "stay loose" about pace; it is important that solid understanding of these initial concepts be acquired.

2) After each explanation, there might be discussion to a) amplify basic points and b) relate these to participants' home situations. (This would also provide a change of pace; concentrated learning of this sort all day is heavy going!) Questions like those on page B-26 could be used as points of departure for discussion. Emphasis should be on students really understanding the basic ideas and being able to adapt procedures appropriately to various circumstances--not just rote memory.

3) Chances are that, during the explanations and discussions, questions will be raised about such "complications" as secondary effects or nonmoney considerations. At this stage probably it is best to give participants some notion of what is entailed, but defer detailed explanation until later, so that the core ideas are not obscured.

4) To "drive home" the key ideas, it is desirable to have participants complete a practice example, such as that on page B-28. This could be done in steps, paralleling class explanations, as either "homework" or classroom exercises.

5) If there is difficulty in grasping discounting, additional exercises could be given, such as sections of Phillip Foster's programmed manual, or the USDA sheets on the Time Value of Money and Discounted Cash Flow.

6) Participants could also be asked to select a simple project from their home setting and carry out the various analysis steps for it as the course progresses.

7) Additional readings could be assigned, or encouraged. Much of Gittinger's Economic Analysis of Agricultural Projects is relevant to Part B, especially pages 15-24, 47-92, 110-129, and 130-147. (Participants should be alerted that his presentation interweaves "financial analysis" with "economic analysis" and various complications.) A number of other books contain good chapters on benefit-cost analysis, or delve more deeply into theoretical underpinnings.

Part C

Economic Analysis

PART C
CORE ELEMENTS OF PROJECT ANALYSIS -- IS IT BENEFICIAL TO THE ECONOMY AS A WHOLE?

The likely effects of proposed agricultural projects on farmers and other specific groups are only part of the story. Development agencies are usually concerned too that projects make a positive contribution to national economic growth. This section focuses on the analysis of project benefits and costs from society-wide perspective.

Key points are...

**Economic analysis centers around the resources and income that a project would drain from, and add to, the overall economy (C-2 and C-3).*

**Economic analysis is built upon the same kinds of "ground level" benefits and costs used in financial analysis, but the items included and the way they are handled may be different (C-4 and C-5).*

**As in financial analysis, benefits and costs are discounted to reflect the "opportunity cost" of capital and to place projects on a comparable basis. But the discount rate used for economic analysis may not be the same as for financial analysis (C-6 and C-7).*

**Prices used for valuing project inputs and outputs should reflect as nearly as possible the contributions they make to economic growth. Actual market prices may not always do this. It may be better to use "shadow prices" for some items (C-8 and C-9).*

**Projects often have indirect (secondary) effects on the overall economy. These are sometimes included in the benefit-cost computations (C-10 and C-11).*

The Essence of "Economic Analysis"

"Financial analysis" deals with the effects of projects on specific individuals or groups, such as farmers. But often a central aim of project proposals is to contribute as much as possible to the overall economic growth and well-being of a nation. A project may be profitable to a small group of persons, yet have little impact on Gross National Product, per capita income, food supply, export earnings, other national development concerns. In fact, a project that is heavily subsidized, or a user of scarce materials, funds, technicians, or foreign exchange balances, could produce a net drain on the overall economy.

"Economic analysis" views and compares projects from this society-wide perspective. Using money equivalents as a common denominator, it seeks to ascertain what the gains to (benefits), and drains on (costs), the economy will be. This analysis focuses on two basic questions:
a) On balance, how beneficial will this project be to society as a whole?
b) Will it be more beneficial than other ways in which that society's public and private resources could be used?

Economic analysis is built upon the same kinds of "ground level" information about investments, labor and land needs, yield effects, etc., that go into financial analysis. It too employs "discounting" to reflect the opportunity costs of resources tied up in a project over a period of years. And similar measures of net return are used--Net Present Worth, Benefit-Cost Ratios, and Internal Rate of Return, among others.

But there are two possible differences between the economic and financial analysis of any given project:

i) The items to be included as benefits and costs may not be the same. What to the individual farmer is an expense or return may not affect the overall economy in a similar way.

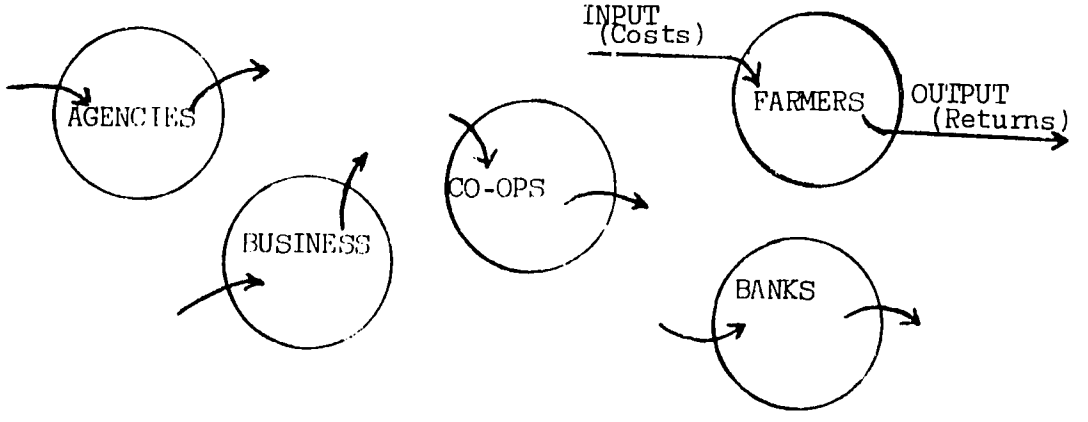
ii) The values placed on these benefit and cost items may not be the same. In economic analysis it is the real growth effects ("shadow prices") on future income streams that count. Actual market prices paid and received will not always reflect these adequately.

As we'll see, land, labor, taxes, subsidies, interest payments, and international trade items are often among those needing such contrasting treatment.

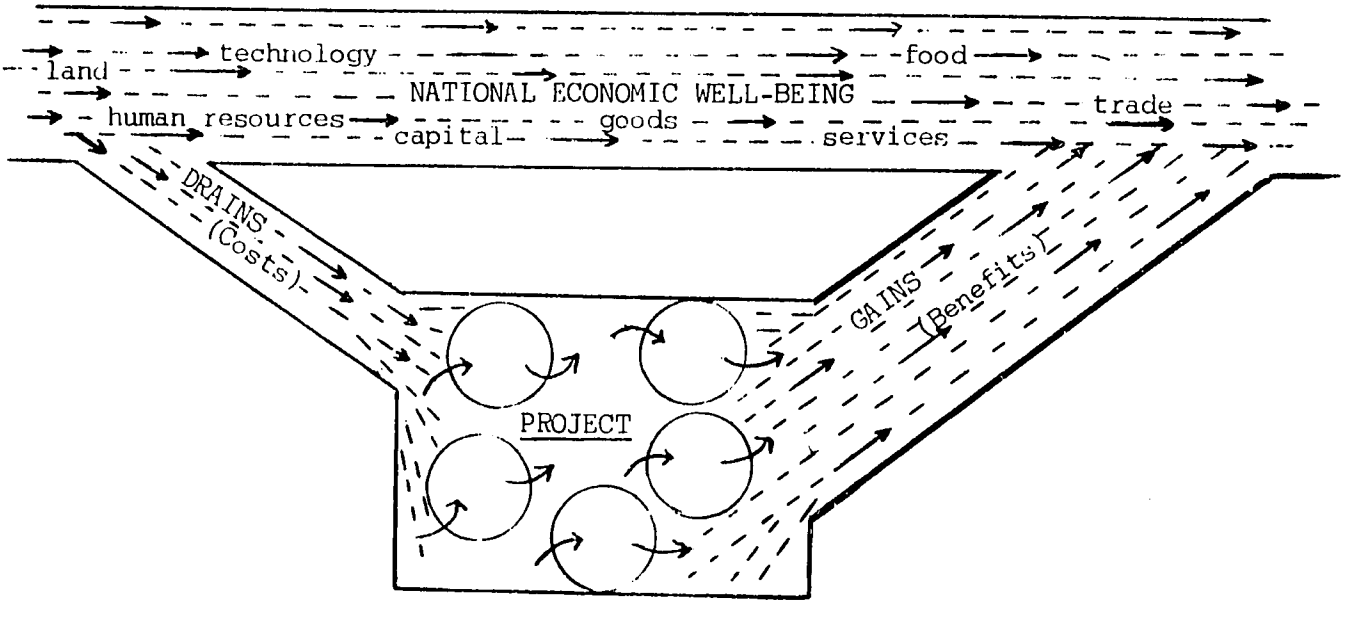
Economic analysis inherently embodies two additional complications: First, the need to aggregate farm level effects to give a project total. (How best to do this?) Second, the need to take secondary or ripple effects of a project into account. (How far to go in tracing and including such indirect effects?)

The pages that follow deal primarily with national economic effects. But economic analysis can be applied to other "social" groupings too--the immediate project area...the surrounding region...the agricultural sector...even the whole world (which some international agencies would stress).

FINANCIAL ANALYSIS PUTS THE SPOTLIGHT ON PARTICULAR PROJECT ENTITIES....



ECONOMIC ANALYSIS ASSESSES PROJECT EFFECTS ON THE WHOLE ECONOMY....



For more about the general nature of economic analysis of projects, and how it differs from financial analysis, see J. Price Gittinger, Economic Analysis of Agricultural Projects, pages 5-8, 67-68, 92-97, and 130-131.

What Benefit and Cost Items to Include?

Economic analysis, like financial analysis, is concerned with the changes generated by a project--changes relative to what would happen if there were no project. But here it is a matter of determining which outlays and returns do indeed affect the national economic growth stream, and when and how. The resulting list of "social" benefits and costs may not be a simple summation of the actual expenses and earnings of farmers and other project entities.

Costs (drains on the economy). Those directly related to a project usually include two types: a) resources tied up in establishing and operating the project itself (for example, construction and maintenance of a dam); and b) resources needed to make productive use of the project (for example, inputs for producing crops on newly irrigated land).

From the national perspective, there may be some "costs" which need to be reflected, even though they don't come out of the pockets of persons or agencies in the project--for instance, government subsidies of fertilizer or seeds...or "free" technical help (if this means less attention to other problems).

On the other hand, some costs which individual project entities incur may not cause drains on the overall economy. Taxes, for example. From a nation-wide viewpoint, taxes that a farmer pays on new income generated by a project are not costs; they are merely transfers of part of the project's gains from one group to another. Likewise, interest charges on domestically borrowed funds used in a project are transfers, and not drains on the economy. In both cases, no direct changes in total resource or income flows take place.

Economic analysis may differ from financial analysis also as to when project costs are accounted for. For example, if loans from domestic sources are involved, the time at which these funds are actually tied up in a project is what counts. This is when they are diverted from other uses in the economy, even though farmers may not pay for their loans until later.

Benefits (gains to the economy). Often these consist mainly of gains in agricultural output. Actual sales or earnings during project lifetime may not reflect all of this; some of the production gains may be used by farm households, or stored and not sold until later. These too should be included as benefits. For some kinds of projects, such as those related to research and education, it may be latent gains in future production that are most important and that need to be reflected as benefits in economic analysis.

Aggregating project effects--a note of caution. For many projects, estimation of total impacts entails multiplying "typical farm" changes by the number of farms. But one has to be careful. All farmers may not respond. There may be several distinct farming situations. Such "slippages" and variations need to be considered when summing up project benefits and costs.

THE GRO-MORE IRRIGATION PROJECT--SOCIAL BENEFIT AND COST COMPONENTS

Returning to our Gro-more example (pages B-3, 4, 5), what benefit and cost items would be included if we wanted to predict the impacts of this project on the national economy?

Social benefits (gains to the economy)

Added vegetable sales.....Each year--$3,000 per farmer x 50 farmers, a total of $150,000 each year

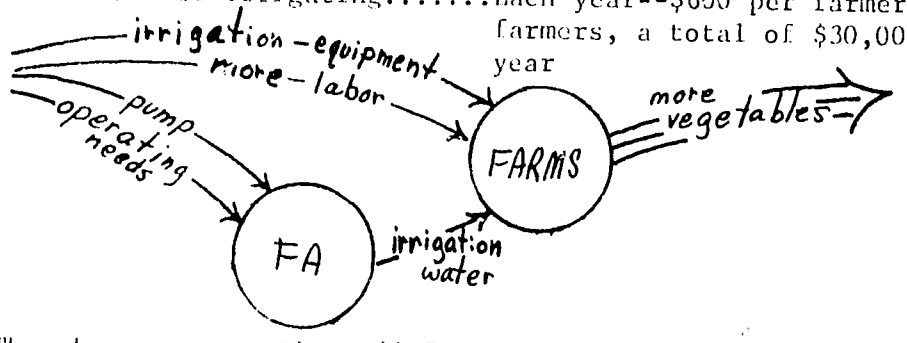
Social costs (drains on the economy)

Pump system bought by the FA.....Year 1--$40,000

FA's costs of operating and.....Years 1-5--$8,000, $9,000, $10,000, maintaining the pump system $11,000, $12,000, respectively

Irrigation equipment bought.....Year 1--$4,500 per farmer x 50 by the farmers farmers, a total of $225,000

Extra labor for irrigating.....Each year--$600 per farmer x 50 farmers, a total of $30,000 each year



**The above assumes that all 50 farmers take part in the project. This may not always be true.

**The above assumes that all the vegetables are sold. If some were consumed by the farm households, those vegetables too should be included as benefits.

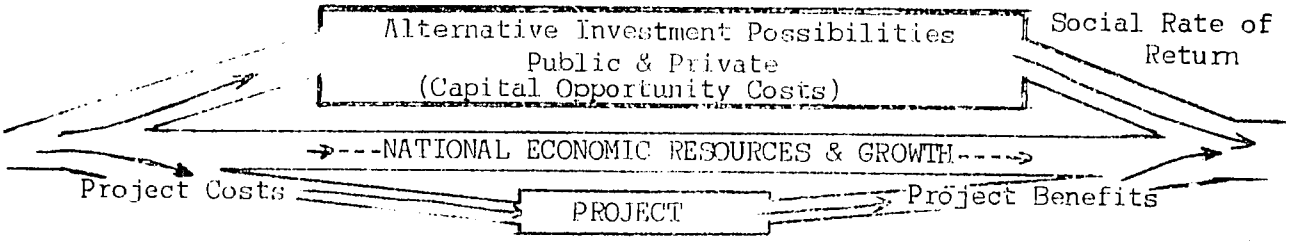
**The irrigation fees paid by the farmers to the FA ($400 each per year) do not enter the social benefit-cost picture. These fees merely are transfers of some project earnings from the farmers to the FA, in return for the services it provides.

**If the FA and farmers had to borrow from the Agricultural Bank to pay for the irrigation equipment, there would be no change in social benefits and costs. Flows from and to the overall economy remain the same. The interest paid to the Bank means only that, in return for its loan, the FA and farmers are now sharing part of their gains with the Bank rather than keeping all for themselves. (For the contrasting way in which financial analysis handles interest charges, see page B-11.)

**This example includes only direct benefits and costs, assumes that market prices reflect the real worth of project inputs and outputs to the economy, and assumes that no public subsidies are involved. In pages to follow we'll see how to handle some modifications of these elements.

Discounting--What Interest Rate to Use?

In economic analysis as in financial analysis, annual project benefits and costs are discounted in order to a) reflect the opportunity costs of resources tied up and b) place projects on a comparable basis with one another. But the discount rate will not necessarily be the same as that applicable to farmers or other specific entities. From society's viewpoint, the relevant rate is the return which capital resources in the nation as a whole could produce if not used for the particular project under consideration. These alternative uses can include not only other development projects, but also nonproject investments related to economic growth that are available to businesses, farmers, financial institutions, the government, and others.



Determining the right "social" discount rate is not easy, for it entails bringing together elusive facts about various investment categories, as well as deciding how much weight to place on each category. Sometimes "standard" rates have been established by national planning agendas. If not, project analysts may be able to obtain some idea of capital opportunity costs by reviewing a cross-section of domestic investment opportunities.

A further element that is sometimes incorporated is the fact that society collectively tends to be interested in long-run gains, whereas businessmen, farmers, and other individuals place greater premium on quick returns. Other things being equal, this leads to a social discount rate that is lower than private discount rates.

Some economists feel that a social discount rate between 8 and 15% is "in the ballpark for most developing countries. A rate of 10 or 12% is commonly used. In any event, the rate selected should reflect i) the returns generated by capital investment opportunities (which will not necessarily be the rate at which funds are borrowed), and ii) the probable capital returns during the future period when the proposed project(s) would be implemented (which may not be similar to average capital returns at present or in the past).

If the appropriate discount rate is not very clear, one way to reduce debate is to compute Internal Rates of Return for the projects being considered. This at least can sort out high- and low-priority projects without having to establish a definitive rate beforehand.

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For some discussion on choice of discount rates, see J. Price Gittinger, Economic Analysis of Agricultural Projects, pages 90-91, as well as the (AID) Development Digest, July, 1973, pages 18 and 33.

THE GRO-MORE IRRIGATION PROJECT: DISCOUNTED MEASURES OF ECONOMIC RETURNS

From page C-5 we can see that the direct social benefits and costs of the Gro-more project, year by year, would be as follows:

	Year 1	2	3	4	5	5-Year Total
	1,000 dollars					
Benefits						
Added vegetable sales	150	150	150	150	150	750
Investment costs						
FA's pump system	40					40
Farmers' equipment	225					225
Other costs						
FA's operating costs	8	9	10	11	12	50
Extra farm labor	30	30	30	30	30	150

Let's suppose that (somehow!) it has been estimated that capital used in, and released from, the project would generage a return of 13% when invested elsewhere in the economy. Annual benefits and costs would therefore be discounted at 13% to compute net present worth and benefit-cost ratios:

	Project Costs			Gross	Discount	Present Worth	
Year	Investment	Other	Gross	Project Benefits	Factor, 13%	Gross Costs	Gross Benefits
	1,000 dollars					-1,000 dollars-	
1	265	38	303	150	.885	268	133
2	---	39	39	150	.783	31	117
3	---	40	40	150	.693	28	104
4	---	41	41	150	.613	25	92
5	---	42	42	150	.543	23	81
						375	527

Net present worth = \$527,000 - \$375,000 = \$152,000

BCR_{all} = 1.4 and BCR_{inv} = 1.6 (See pages B-20 and 21 for how to calculate.)

Using trial-and-error and interpolation as explained on pages B-22 and 23, the Internal Rate of Return (IRR) turns out to be 61%. Sometimes the IRR for economic analysis is called "Internal Economic Return" as distinct from "Internal Financial Return."

What Values to Use? Market Prices vs. "Shadow Prices"

The aim of economic analysis is to gauge the real worth of project inputs and outputs--the future productivity and well-being foregone or generated in society as a whole. In a well working economy, market prices of construction materials, farm supplies, labor, and commodities will tend to reflect this social worth (which economists sometimes call "marginal value productivity"). But in practice these prices may be distorted by lack of supply and demand information, resource immobility, imperfect competition, price ceilings, and other impediments. So "shadow prices" which match true social worth may have to be computed for some project items. (This is in contrast to financial analysis, which is concerned with actual earnings of project entities and always uses market prices.) Among the project items that may need such adjustments in economic analysis are the following:

Labor. Minimum wage laws, union bargaining, or "exploitation" by employers may cause earnings of some workers to differ from the true contributions they make to economic growth. If unemployment is widespread, the added labor needs of a project may not mean diverting workers from other productive uses; the social cost (shadow price) of such labor would be zero, not the actual wage. Family workers, even though unpaid, do incur a social cost if a project results in their foregoing other jobs or giving less attention to other farm enterprises.

Land. Government land donated for project use may not in fact be "free" from the economy's viewpoint, if that land could have been put to such other productive uses as timber production, mining, or urban development.

World trade commodities. Farm products that are, or could be, traded internationally often should be valued at world prices (with adjustments for transport, quality, etc.), even if they are used domestically. If local prices are lower than world prices, the option of exporting exists. If local prices are higher than world prices, the option of importing to meet domestic needs exists.

Exchange rates. Official foreign exchange rates are not always in line with true currency values. They may distort the real worth of project imports that are imported, or of project outputs that are exported. Pricing adjustments may be needed.

In all this, it is important to use values which correspond to where the project action is and to be consistent from project to project. If the main effects are on agricultural production, farm level prices would normally be used. (But, as seen later, indirect effects on suppliers, processors, etc., are sometimes taken into account too.)

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The extent to use shadow prices instead of market prices in economic analysis of projects is much debated by economists. For more discussion, see J. Price Gittinger, Economic Analysis of Agricultural Projects, pages 31-46. Also the AID Development Digest, July, 1973, pages 10-17 (summary of Gittinger's book) and pages 28-35 ("A Guide to Little/Mirrlees").

THE GRO-MORE IRRIGATION PROJECT--SHADOW PRICING

To illustrate the points on page C-6, let's assume for the moment four basic changes in the Gro-more situation:

1) That the extra farm labor needed for the irrigation would come from family members who are now not used on the farms and who do not have work opportunities elsewhere. Therefore, the drain on the economy would be zero, and no cost for this extra labor needs to be included.

2) That the Agricultural Extension Department agrees to supply "free" specialists to the farmers and the FA during the first year to help get the irrigation system going. But this means that the Extension specialists have to reduce time spent with other groups, with a resulting loss of production gains by these other groups estimated at $20,000. Accordingly, the Extension help to the Gro-more project entails a social cost of $20,000.

3) That the FA's irrigation pump system is imported from abroad, and it is found that the $40,000 cost figure has been based on an official foreign exchange rate which is unrealistic. At the exchange rate which is used in commercial channels and by national planners, the real cost of the equipment would be $60,000. This latter amount should be "charged" to the Gro-more project.

4) That an international market is emerging for the kinds of vegetables grown by the Gro-more farmers. A nearby developed nation will buy all that the Gro-more farmers' country can produce, at a farm level price which is 20% above the domestic price. (Regulated market ceilings have held down domestic vegetable prices.) Also, these vegetables could be imported from other nearby countries at a similar international price. Therefore, the real value to the economy of the added Gro-more vegetable output under irrigation would be 20% greater than the $3,000 per farmer per year used so far--or $3,600.

The resulting economic benefit and cost components of the Gro-more project would therefore be as follows:

Benefits - Added vegetable sales....$3,600 per farmer x 50 farmers = $180,000 per year

Costs - Extra farm labor.....No opportunity cost
Extension help.....Year 1--$20,000
FA's pump system.....Year 1--$60,000
FA's operating costs.....Years 1-5--same as before
Farmers' equipment.....Year 1--same as before

Indirect Benefits and Costs

From society's viewpoint, the investments and outputs directly tied to an agricultural project are not the only economic effects. There often are indirect (or "secondary") benefits and costs. Some of these may have strong impacts on people far removed from the project itself. To what extent, if at all, should such indirect effects be taken into account? This is a much debated aspect of project analysis, with no hard-and-fast answers. Here we shall distinguish among five categories of indirect effects:

1) Forward-linkage ("stemming from") effects--changes in activities that link project output to the final consumer. Fox example, the added net output of marketing firms which have more business as a result of a "Green Revolution" project.

2) Backward-linkage ("induced by") effects--changes in activities that provide inputs needed by a project. For example, the increase in fertilizer production required to undergird a "Green Revolution" project.

3) Ripple ("multiplier") effects--the more widely diffused chain of increases in incomes and expenditures that is generated by a project. For example, farmers with higher earnings may buy more goods from shopkeepers, who in turn earn and spend more, etc., etc.

4) External scale effects--changes in per-unit costs or returns to persons who are not directly associated with a project. For example, the higher cost of drilling wells nearby if an irrigation project lowers the water table.

5) Side effects--economic benefits or costs not related to basic project scope. For example, savings in malaria control costs from an agricultural project involving land drainage. (Here we are talking about economic side effects. As seen later, project analysis may also include noneconomic effects, both tangible and intangible.)

Including indirect effects may be especially appropriate if there is considerable "slack" in the economy--unemployment, idle capital, etc.; they may indeed be economic gains. However, if resources are already heavily used, indirect benefits may be "canceled out" by diversion of these resources from other income-producing channels.

If indirect effects are included, there are three common ways to handle them: a) adding them to the direct benefits and costs, b) treating as a separate set of benefits and costs, or c) modifying prices used for benefits and costs. In any event, care should be taken to avoid "double counting" and to include indirect costs that are associated with indirect benefits.

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For further discussion, see J. Price Gittinger, Economic Analysis of Agricultural Projects, pages 24-29. Also Secondary Impacts of Public Investment in Natural Resources, USDA Misc. Pub. 1177, 1970.

THE GRO-MORE IRRIGATION PROJECT:
SOME POSSIBLE INDIRECT BENEFITS AND COSTS

In the Gro-more example, some possible indirect (secondary) effects on the overall economy might include the following:

Forward linkages....Added volume of business for vegetable handlers in Gro-more Town and Grand Center.

More transport, shipping crates, and other inputs needed by these handlers.

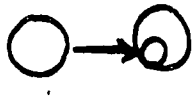
More jobs in the vegetable handling chain for the unemployed.

Backward linkages...More business for local repair shops.

Increased volume for domestic suppliers and manufacturers of irrigation pumps, pipes, etc.

Ripple effects.....Gro-more farm families and the new hired labor spend more in Gro-more Town for living items and luxuries. Local shopkeepers, in turn, buy more supplies from Grand Center, as well as spend more themselves for family items.

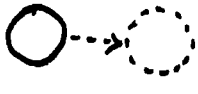
External scale effects.....If the irrigation system uses a significant portion of the water in the Gro-more River, Gro-more Town and other downstream users may have higher costs of meeting their water needs.



Households in Grand Center may be able to buy vegetables at lower prices.

If the FA staff and facilities have been under-utilized, the irrigation project may lead to lower overhead costs for other FA activities.

Side effects.....Grand Center families may eat more vegetables, have better diets and lower medical expense.



The project could have a "demonstration effect" on other farmers in the Gro-more area or elsewhere...stimulate them to irrigate too.

Success with this project could generate more local confidence in the Gro-more FA...lead to greater interest in other FA undertakings to increase production and incomes.

Can you think of other possible indirect effects?

Some Questions for Thought and Discussion

1) How would "social" benefits and costs be affected by the following changes in the basic Gro-more example (page C-5)?

   a) If each vegetable farmer had to pay 20% income tax on his net earnings from the irrigation project.

   b) If only 30 farmers decided to participate in the irrigation project.

   c) If the government had some "surplus" pumps lying around unused, and donated one to the Farmers Association free of charge.

   d) If, at the end of five years, the Farmers Association could sell the old irrigation pump for a salvage price of $5,000.

   e) If the farmers' irrigation equipment had to be purchased from abroad and, as a result, they each had to pay $4,500 plus 10% import duty.

   f) If, above the market price for vegetables, the government paid farmers a 15% subsidy (support price) for each kilo of vegetables sold.

2) When choosing the social discount rate to use in economic analysis, should the alternative (nonproject) investment opportunities of farmers and other entities <u>within</u> the project itself be included? Or should this rate reflect only the investment returns of <u>others</u> in the economy?

3) Explain in your own words why market prices <u>may</u> not be appropriate for all benefit and cost items in economic analysis.

4) Suppose you are estimating the economic effects of a proposed land reform scheme, in which large estates would be subdivided into small holdings. This land-transfer project in itself would not bring about any changes in farm practices, output, or earnings. How would economic benefits and costs be handled in this situation?

5) Suppose you are comparing two alternative projects that relate to distinctly different stages in the production-marketing sequence: a) a beef herd improvement campaign for livestock producers, and b) a new meat processing plant. To make a meaningful comparison, how would prices of the livestock involved be handled in each instance?

6) Suppose AID is ready to provide a special loan to finance the purchase of the irrigation pump and equipment for the Gro-more project. The principal and interest would be repaid at the end of the five years. Would this change the economic benefit-cost calculations as shown on page C-7? If so, how?

7) How would the Gro-more economic benefit-cost calculations be affected if financing came from an AID loan that had previously been made for development of the agricultural sector in general over a period of many years? (That is, the AID loan has already been used for other projects, the Gro-more financing would come from principal and interest channeled back into the economy, and repayments to AID would not be made until 20 years from now.)

8) How would the Gro-more economic benefit-cost calculations be affected if AID provided the irrigation pump and equipment as a grant?

9) Suppose that the Gro-more vegetable farmers and their families spend one-third of their gross added earnings from the project for consumer purchases. In turn, the shopkeepers from whom they buy spend one-third of their added sales for consumer purchases. And so on down the chain. If one were tracing the cumulative "multiplier effect" out through the entire chain, how much would each added dollar of Gro-more farmer earnings generate in consumer purchases?

10) Suppose that AID is considering financing the Gro-more project in the fashion depicted in Question 6), and is weighing this proposal against project proposals in other developing countries. If AID's objective is to use these loan funds to increase the value of agricultural output in the world as much as possible, how would the benefit-cost analysis of the Gro-more project be handled from this viewpoint? Would it be the same as from the national viewpoint?

11) One aggregative effect of large projects may be that prices in the whole nation are changed as a result of project demands for certain inputs, or project additions to national production. Can you cite examples from your own experience where projects have had such effects?

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Practice Exercise

Recall the proposed Gro-more ding berry project depicted on page B-28, which was used for practice of financial analysis and discounting procedures. Assuming the initial facts to still be the same:

1) List the items that should be included as benefits and costs if one were to estimate the effects of this project on the overall economy.

2) Using an economy-wide opportunity cost of capital of 11%, calculate a) Net Present Worth, b) BCR_{all} and BCR_{inv}, and c) Internal Rate of Return (Internal Economic Return) from this national economic perspective.

3) Indicate whether there are any benefit or cost items in this ding berry project proposal for which it may be desirable to use "shadow prices" instead of actual market prices.

4) Indicate the indirect (secondary) benefits and costs that may result from this project.

Some Ideas for Teaching Part C

1) A basic teaching approach similar to that used in Part B (financial analysis) would probably be appropriate--concise explanation of one or two key points at a time, interspersed with fairly short discussion sessions and practice exercises. (See pages C-12, 13, 14 for some ideas.)

2) It is important that, at the outset of Part C as well as throughout, participants have a clear view of the basic intent and nature of economic analysis, as contrasted with financial analysis. Posting a large "gain-drain" flow chart similar to that on page C-3 may help to keep specific points in perspective, as well as serve as a point of departure for discussing any complex issues raised.

3) Some facets of economic analysis are less cut-and-dry than financial analysis--for example, whether to use shadow prices or to include indirect effects. Agencies vary in how they handle such components. So rather than the instructor trying to provide definitive answers about what ought to be done, a tone of mutually thinking through how these issues might be treated, or relating how competent analysts have sometimes handled them, would be more productive.

4) In the same vein, an experienced project analyst might be invited to interact with the group toward the end of Part C to explain how he handles the more complicated issues of economic analysis, and to help the group think through specific questions that may have been satisfactorily answered up to that stage.

5) If the participants seem to have by the end of Part B a firm grasp of the mechanics of discounting, computing the various measures of return, etc., there probably is no need to do calculations related to all the economic analysis points presented. However, if they are still a bit shaky, applying actual numbers to the Gro-more illustrations related to shadow pricing, borrowing situations, etc., might be good.

6) If in Part B participants have started analyzing specific project situations from their home countries as an individual exercise, it would be well to carry this through the economic analysis, too.

7) For core reading related to economic analysis of projects, the cited sections of Gittinger's book are very helpful. Some groups may want and be able to handle readings or discussions of a more "theoretical" nature on such topics as shadow pricing, indirect effects, links of international monetary exchange and trade to project analysis, external economies and diseconomies, and project linkages to aggregate supply and demand relationships.

Part D

Some Complications and Refinements

PART D
ADDITIONAL CONSIDERATIONS IN PROJECT ANALYSIS

Project analysis is seldom, if ever, a simple, straightforward task of data collection and computation of benefit-cost ratios, net present values, and internal ratio of return. These evaluative measures are the principle tools of the analyst. They often constitute the primary focus of project analysis, and within the scope of their appropriate use, should be applied and presented with objectivity. However, granted the central importance of these measures, it is essential to recognize that at both levels of project analysis--financial and economic--there are complications and refinements that require careful consideration if the analysis is to give a complete and accurate picture of the project's effect at both the local and national level. Some of these considerations can be handled empirically, while the intangible nature of others makes both their inclusion and measurement quite subjective. This subjectivity does not however diminish their importance.

The literature on benefit-cost analysis is filled with debate on how many of these additional considerations should be measured and what weight they should be given in the analysis. It is not the intent of this chapter to provide a detailed presentation of this topic, nor offer new solutions to the problem. Rather, the sole intent is to make the would-be analyst aware of the existence of these complications, and suggest ways they might be included in the analysis.

The key points are...

** *Nonincome criteria in project analysis.*

** *The trade-off idea -- its use in project analysis.*

** *Taking intangibles into account.*

** *Sunk costs.*

** *Dealing with uncertainty.*

** *Dealing with inflation.*

1. Nonincome Criteria

Benefit-cost analysis is income oriented. Its central objective is to determine the effect a proposed project will have on the level of net income and ultimately on economic growth. In addition to the income effect there are usually other tangible, but nonincome consequences of the project. For example:

1. Employment - the number of jobs created or eliminated by the project.

2. Income distribution - the effects on low-income groups.

3. Timing of benefits - politicians often want quick payoffs.

4. Requirements for fuel and other scarce resources.

5. Requirements for professionally-trained manpower.

6. Foreign exchange requirements.

Many of these effects are interrelated, for example, employment and income distribution. Projects of different magnitude, in different locations, and of different design will have different effects on employment and shift income in different amounts to different people in different time periods.

In many societies a politician's success depends on his ability to gain and maintain public support in the short run. This is his base for political power. For this very pragmatic reason, politicians often tend to favor projects that give benefits in a brief period of time. This allows them to demonstrate their effectiveness to their constituency prior to the next election. Conversely, projects requiring substantial initial investment but necessitating a long period prior to providing significant benefits generally have more difficulty receiving political approval.

Presently many nations are experiencing severe fuel shortages. In such a situation it would be important to evaluate what effect the proposed project would have on fuel requirements. If a project would greatly increase fuel needs and further aggravate current shortages, it might be better to delay the project until more plentiful supplies are available or choose an alternative project having a lower fuel requirement. Similar arguments could be made in regard to other scarce resources including trained manpower and foreign exchange.

2. The Trade-off Idea

Any single project probably will not be better than all other alternatives with respect to all of these criteria. In order to get more of one thing, it will often be necessary to give up something else. A trade-off between one consideration and another may be involved. A project might provide a significant gain in income, as shown by a high net present worth and internal rate of return, but displace many rural people. In instances where two or more considerations are taken into account, the best choice of project depends on how much weight is given to each consideration. This is usually a political decision. The trade-off concept is shown in the Gro-more example below:

GRO-MORE FARMER - Trade-off Between Two Criteria

Project Alternatives	Income Effect (BCR_{all})	Change in Farm Employment
Vegetable Irrigation	1.42	+10%
Contract Spraying	2.00	- 8%

There is a trade-off between these two projects. The benefit-cost ratio indicates that greater net benefits would be realized from contract spraying. However, implementation of this project would cause 8% of the farm labor force to lose their jobs. This reduction in the farm labor force could add to unemployment problems in surrounding urban areas. On the other hand, the vegetable irrigation project, while providing a smaller gain in income, would cause an increase in employment opportunities. Deciding on this trade-off could be very important -- especially in a labor-surplus economy.

3. Taking Intangibles into Account

Besides nonincome considerations, there may be some intangible effects of the project that are difficult to measure in terms of money. These effects might include:

1. Difficulty of administering the project
2. Social disorder
3. Health
4. Family security

5. National and social integration

6. Environmental quality

Evaluation of these effects in absolute terms is difficult if not impossible. They should, however, be recognized and thoroughly considered in the analysis of the project. One way that this can be done is to provide an estimate of the relative effects of alternative projects by using some type of ranking scale, such as 1, 2, 3, 4, 5, that is based on subjective judgment and experience. This is illustrated in the example below:

GRO-MORE FARMER - Trade-off Situation Including Intangibles

Project Alternatives	Income Effect	Nonincome	Intangibles[1/]	
	BCR all	Change in Farm Employment	Ease of Administration	Social Unrest
Vegetable Irrigation	1.42	+10%	3	1
Contract Spraying	2.00	- 8%	1	4

Here again is a trade-off situation involving the subjective ranking of two possible intangible effects of alternative projects. Accordingly, it is believed that the vegetable irrigation project would be more difficult to administer than the contract spraying. This is because the irrigation project is larger and involves buying and installing equipment. Also the contractor doing the spraying would probably handle much of the daily administration of that project. In contrast, it is indicated that the contract spraying project would cause greater social unrest since it would cause greater unemployment, whereas the irrigation project would create jobs.

4. Sunk Costs

Sunk costs refer to those expenditures already made on a project. Sometimes a project that has been started is abandoned prior to its completion. The sunk costs of the project would be all investments and costs incurred by the project prior to the time it was abandoned. It is most important to recognize that sunk costs should not be a consideration in project analyses. As has been previously stressed

1/ Subjective scale from 1 - 5; higher the number , greater the effect.

project analysis is concerned only with future costs and future returns. Therefore, the amount already spent (sunk) on an abandoned project is inconsequential in deciding whether or not it should be completed. In some cases only a very small additional investment in an abandoned project may raise future benefits from zero to a substantial level.

In another instance the economic situation might change drastically after the project has been initiated. For example, operating costs may rise or fall, making it advisable to reevaluate the project to determine whether or not it should be continued. Here again, what has already been sunk into the project does not matter, only the future costs and benefits should be considered. The concept of sunk cost is illustrated on page D-6

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For more about the handling of sunk costs, see J.P. Gittinger, Economic Analysis of Agricultural Projects, pages 106-107.

GRO-MORE FA - SUNK COST EXAMPLE

Suppose the FA has already installed the central pumping system and in the third year a substantial rise in fuel prices cause operating costs to increase by $1,000 per year.[1] Should the FA continue?

	Year 1	2	3	4	5	3 Year Total
	-dollars-					
Without the project	(same as shown on B-5)					
With the Project						
Costs:	Sunk Costs-Disregard					
Usual services and sales	60,000	60,000	60,000	60,000	60,000	180,000
Purchase of central pump	40,000					
Operation & maintenance	8,000	9,000	11,000	12,000	13,000	
Income:						
From usual services and sales	70,000	70,000	70,000	70,000	70,000	210,000
Water fees from 50 growers	20,000	20,000	20,000	20,000	20,000	20,000
Net FA income	(18,000)	21,000	19,000	18,000	17,000	54,000

Discounted Values of Costs and Benefits for 3 Years

Costs:

11,000 x .909 = 9,999
12,000 x .826 = 9,912
13,000 x .751 = 9,763
28,674

Benefits:

20,000 x .909 = 18,180
20,000 x .826 = 16,520
20,000 x .751 = 15,020
49,720

$$BCR = \frac{49,720}{28,674} = 1.73$$

[1] For purposes of this example assume that this increase in cost is not passed back to the farmers in higher water fees.

5. Dealing with Uncertainty

Any project analysis is based on expectations of future events. Since the future is difficult to predict, these expectations are subject to various sources of uncertainty. In the case of agricultural projects the major sources of uncertainty include commodity prices, timing of project initiation and completion, yields and production costs. Wide deviations of any of these factors from the estimates used in the initial analysis could have serious consequences. For this reason it is essential that the possible effects of uncertainty be carefully examined. There are three principal ways of dealing with uncertainty:

1. Use of a higher discount rate to reflect the uncertainty of a project.

2. Use of sensitivity analysis to predict the outcome under alternative conditions.

3. Use of a contingency allowance.

None of these approaches is difficult. The use of a higher discount rate to reflect uncertainty is straightforward. If at successively higher interest rates, project benefits continue to exceed project costs (BCR>1), one may conclude that the potential benefits are well worth the uncertainty involved.

Actual events never coincide exactly with their predictions. The use of sensitivity analysis simply involves recalculating measures of project worth using different estimates for costs and benefits. This procedure permits explicit determination of what would be the income effect of a project if, say, costs increase 25 percent over the original estimate, product prices decline 15 percent, crops yield turn out to be only 80% of the initial estimate, or the period of project duration must be extended. Project analysts' have found sensitivity analyses to be a most useful technique. All projects should be subjected to sensitivity analysis and the results should be included in final report on the analysis.

In preparing an analysis, estimates of project costs are generally based on assumptions of optimum operating conditions, a stable price level, and an absence from adversities such as floods, earthquakes, labor strikes, etc. that could prolong the project. Certainly these are unrealistic assumptions. Contingency is often defined as the possibility of an unidentified occurrance. Thus, a project contingency allowance is a certain amount of funds set aside to cover unforeseen events that would increase project costs. In this way contingency allowances provide for the uncertainty of project cost estimates and help insure that funds for project completion will be adequate. Generally these allowances are included in the analysis by adding some specified amount (say 10 percent) to the initial cost estimates.

The example on page D-8 illustrates the use of sensitivity analysis as a means of considering uncertainty.

TYPICAL GRO-MORE FARMER - EXAMPLE OF SENSITIVITY ANALYSIS

Assume the cost of needed irrigation equipment to be $6,500 (rather than $4,500). Further assume that returns from vegetable sales to be $7,500 (rather than) $8,000. What would be the effect on the project analysis?

	Year 1	2	3	4	5	3 Year Total
	- - - - - - - - - - dollars - - - -					
Without Project	(same as shown on B-4)					
With Project						
Costs:						
Usual production expenses	3,000	3,000	3,000	3,000	3,000	15,000
Purchase of irrigation equipment	6,500					6,500
Payments to F.A. for water	400	400	400	400	400	2,000
Extra labor for irrigating	600	600	600	600	600	3,000
Returns: Vegetable sales	7,500	7,500	7,500	7,500	7,500	37,500
Net returns to grower	(3,000)	3,500	3,500	3,500	3,500	11,000
Changes stemming from project						
In costs:						
Irrigation equipment	6,500					6,500
Water fees	400	400	400	400	400	2,000
Extra labor	600	600	600	600	600	3,000
In returns: Added vegetables	2,500	2,500	2,500	2,500	2,500	12,500
In net returns to grower	(5,000)	1,500	1,500	1,500	1,500	1,000

Present worth of costs = 9,410
Present worth of benefits = 9,014
Net present worth of project to farmer = $9,410 (costs) - 9,014(benefits) = (396)

$$BCR_{all} = \frac{9014}{9410} = .957$$

6. Dealing With Inflation

Inflation, to a greater or lesser degree, has been a fact of life in most nations. It can only be assumed that these inflationary pressures will continue to exist. It is important to recognize and evaluate what effect this increase in price level has on the analysis of a project.

Two basic inflationary situations exist:

1. A general and uniform rise in price level where the value of all costs and benefits increase by more or less the same proportion.

2. A differential non-uniform rise in prices where the prices of some items increase more than others.

There are several ways these situations can be accounted for. If it is realistic to expect a general, uniform rise in all prices, it can be assumed that their relative relationship will not change. In this case present prices can be used to compare projects. In practice, this procedure gives the same result as deflating all prices by a selected price index.

A general uniform rise in price level can also be dealt with by using a higher discount rate. Here the reasoning is similar to that given for using a higher discount rate to account for uncertainty.

If, on the other hand, a differential, non-uniform rise in prices is expected the above procedures are not appropriate. Here it is necessary for the analysis to consider the relative change among prices. Here, the most common procedure is to inflate only those prices expected to rise while holding all other prices constant.

Contingency allowances are also used to account for inflation. However, how they are used differs depending on whether the price rise is general and uniform or relative. In the case of relative price changes the contingency allowance is added to other project costs when computing the various measure of project benefits.

In dealing with a general and uniform rise in prices it has been indicated that a common practice is to compute measures of project worth at present prices. However, if this procedure is used a danger must be recognized. If inflation does occur cost estimates figured at present prices may result in a financial squeeze during later stages of the project. To avoid this, project financing must provide an adequate source of funds. This is done by estimating the amount of inflation in absolute terms and putting this amount in a contingency fund that is

added to the general pool of funds allocated to the project. Note however that in this instance the contingency fund is not added to project costs when computing measures project returns and value.

* * * * * * * * * * * * * *

For more about the use of sensitivity analysis, contingency allowances, and other techniques in dealing with inflation and uncertainty, see J. Price Gittinger, Economic Analysis of Agricultural Projects, pages 37-38 and 99-104.

GRO-MORE FA -- DEALING WITH DIFFERENTIAL, NON-UNIFORM INFLATION USING A CONTINGENCY ALLOWANCE

Assume that to cover anticipated differential, non-uniform inflationary pressures a $1,000 per year contingency allowance is added to project costs:

	Year 1	2	3	4	5	5 Year Total
	- - - - - - - - - - dollars - - - - - - - - -					
Without Project	(Same as shown on B-4)					
With Project						
Costs:						
Usual services and sales	60,000	60,000	60,000	60,000	60,000	300,000
Purchase of central pump	40,000					40,000
Operation and Maintenance	8,000	9,000	10,000	11,000	12,000	50,000
Contingency allowance	1,000	1,000	1,000	1,000	1,000	5,000
Income:						
Usual services and sales	70,000	70,000	70,000	70,000	70,000	350,000
Water fees	20,000	20,000	20,000	20,000	20,000	100,000
Net FA income	(19,000)	20,000	19,000	18,000	17,000	55,000
Changes Stemming From Project						
In Costs:						
Central pump	40,000					40,000
Operation and maintenance	8,000	9,000	10,000	11,000	12,000	50,000
Contingency allowance	1,000	1,000	1,000	1,000	1,000	5,000
In Income:						
Water fees	20,000	20,000	20,000	20,000	20,000	100,000
In Net FA income	(29,000)	10,000	9,000	8,000	7,000	5,000

Present worth of costs = $77,318
Present worth of benefits = 75,780
Net present worth of project to FA = 77,318 (costs)-75,780 (benefits)
= (1,538)

$$BCR_{all} = \frac{75,780}{77,318} = .980$$

Some Questions for Thought and Discussion

1) Several examples have been given of non-income and intangible considerations in project analysis. Based on your own country, can you add to these examples?

2) What is the difference between non-income criteria and intangibles? Can they be related in project analysis? How?

3) What procedure would be necessary to determine values for the non-income criteria?

4) In your opinion, to what extent should these non-income and intangible considerations be included in project analysis? Is your answer the same for both financial and economic analysis?

5) What is meant by the "trade-off" concept? How is it used in project analysis?

6) What are sunk costs? Why shouldn't they be included in project analysis when deciding to continue or abandon a project?

7) In contrast to the sunk cost concept, give an example of when it might be useful to use all previous benefits and costs.

8) What is meant by sensitivity analysis? What is its usefulness in project analysis?

9) In addition to sensitivity analysis what are two other ways to deal with uncertainty in project analysis?

10) What are two types of inflationary situations? Explain how they differ?

11) How can each of these inflationary situations be handled in project analysis?

12) When a situation of general-uniform inflation is expected, constant prices are often used in project analysis. What is the danger of doing this in terms of actually financing the project? How can this danger be overcome?

13) Under what inflationary situation is it appropriate to add a contingency allowance to project costs?

14) Inflation can occur at different rates at different times during the life of the project. Suppose relatively rapid inflation is experienced near the end of the project. What might be the effects on the costs and benefits of the project? On the other hand, assume rapid inflation in the initial stages of the project followed by a period of relatively stable prices. What would be the effects on benefits and costs in this instance?

15) Could sensitivity analysis be used to handle inflation in project analysis? How?

Some Ideas for Teaching Part D

1) This is an interesting and controversial topic. There are numerous examples and many questions that do not have definitive answers. It is easy for the presentation and discussion to drift from the main points. As a result, the instructor has to be especially skillful in keeping the discussion focused on the key elements. Use of appropriate visuals assists in disciplining the discussion.

2) It is suggested that the section be taught in a one-half day session broken into two parts. The first part consists of the introduction and presentation of the topics on non-income effects. Intangibles and trade-offs. The second part covers the remaining types of sunk costs, uncertainty and inflation. Relevant group discussion should follow the presentation of each topic.

3) The concept of sunk costs is often especially difficult to grasp. Several specific examples should be used as a means of clarifying this concept prior to permitting group discussion. Premature group discussion only serves to increase the confusion.

4) The use of sensitivity analysis should be stressed as a way of dealing with various types of uncertainty.

5) This is a good time to remind the participants of the distinction between the roles of the project analyst and the decision-maker. It is the analyst's responsibility to gather data, analyze, organize and present a comprehensive, objective and accurate analysis to the decision-maker. It is the decision-maker's responsibility to consider this analysis in his final judgement.

Part E

Analysis at the Farm Level

PART E

PROJECT EFFECTS AT THE FARM LEVEL

This section deals with the likely effects of a proposed project to the individual farmer. Methods of evaluating these results at the farm are discussed along with some basic principles which will guide you in making an analysis on the farm.

Key points are...

** *Determine present on-farm situation including land, labor, and capital available. The present level of production by the farmer in the proposed project area is also important.*

** *Determining the potential changes to be brought about on the farm.*

** *Basic principles of farm management are important guides in field analysis. These include comparative advantage, diminishing physical and economic returns, substitution, fixed and variable costs, and opportunity cost.*

** *A review of tools which can help determine on-farm effects including total and partial budgets and their importance.*

** *Consideration of characteristics of the project which may or may not result in favorable action by individual farmers.*

** *Interpreting the facts is a step in analysis at the farm level and a review of the possible need to adjust the farmer's terms of trade.*

** *Some special problems are reviewed in aggregating on-farm responses to the project level.*

** *Review of sampling approaches appropriate for collecting on-farm data.*

1. A Closer Look at the Analysis of Project Effects on the Farmer

The basic questions are:

> Are farmers helped by the proposed project and, if so, how much?
>
> Are farmers likely to gain enough benefits from the project to be motivated to fully participate?

To determine what the benefits are likely to be with the new project, one must first determine the present situation.

Identifying a Typical Farm Situation

This is a basic starting point in the analysis of a typical farm. One must first determine what basic resources are available, such as:

Land: How much land does the typical farmer have, and what is its productive capacity? Does this land have any serious limitations, such as steep slopes, poor drainage, infertile soil, too little or too much rainfall, or short length of growing season?

Labor: It is necessary to determine how much labor the typical farmer has available on his farm, and how much of this is utilized. In many developing countries there will be a surplus of labor or much labor that is underemployed. You should also determine the skill of the labor available on the farm -- how much training will be required for the average farmer to produce a new cash crop?

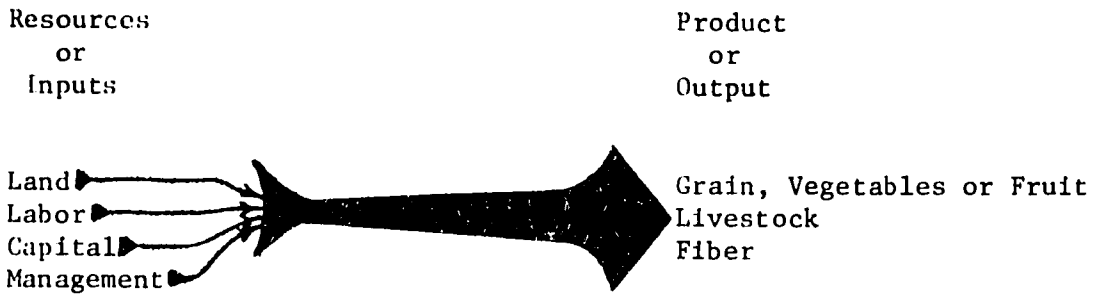
Present Level of Production: It is important to determine how much farm produce is now being produced per hectare. The present level of yields of basic food crops and any cash crops is an important fact needed for future budgeting and planning purposes.

Capital: Capital includes all those tangible things other than land and labor which are used to carry out the farm production process. It will be important through interviews with farmers to determine what capital goods are available on the typical farms, such as:

- Farm power on hand -- animal or mechanical
- Farm machines -- implements and tools
- Productive livestock -- cattle, goats, sheep, pigs, and poultry
- Land structure for soil conservation and water control
- Seeds, fertilizer, feed, fuel, chemicals, and other supplies
- Buildings -- storage, housing, and others

2. Pinpointing the Potential Kinds of Changes to be Brought About by This Project

In our further analysis of projects at the farm level it is necessary to determine what exact changes will take place on the typical farm. Let's look at the farm business from the viewpoint of the farm operators. The farmer, however small or large, traditional or commercial, combines four types of resources to produce a product. We might view this as follows:



Each farmer must decide how the resources of land, labor, and capital should be used. The farmer must decide on the kind of crop plan to use; whether to produce livestock as well as crops; how much labor, power, and implements to use; when to plant and harvest; whether to use credit and how much; how much to consume and how much to market; and all the rest. All of these are decision-making problems. In summary, it can be said that the five major decisions made by farmers are as follows:

1. What to produce
2. What methods of production to use
3. How much to produce
4. When to buy and sell
5. Where to buy and sell

It's not only a matter of wise choices, but also skill in carrying these out -- the "art of farming", timing, careful attention to disease and pests, etc. -- affects what economists call "input-output" relationships.

A Look at the Gro-more Irrigation Proposal at the Farm Level

The farm businesses of the 50 farmers who specialize in vegetable production should be closely examined. Some of the items on which more information is needed are:

Land: Size of the typical farm, number of acres, and constraints to production. Water is one constraint in the Gro-more area. The Gro-more irrigation project will remove this constraint. However one will need to determine if other constraints exist, such as soil unsuitable for irrigation or topographic features of the land which might restrict irrigation.

Labor: The 50 farmers have, in the past, been employing people who have been growing vegetables. Now with a major resource change (water), how can these farmers best produce the product? One obvious advantage they have is experience in growing vegetables. However, they do not have experience or skills in handling irrigation water. Is labor available for the increased work load associated with irrigating vegetables and producing more vegetable crops per year? It is also necessary to determine the skills needed and how they can be taught to the farmers of the area.

Capital: What are the capital items available to the typical Gro-more farmer? It is important that, by interviews and observation, the farm machinery, power, seed inventory, and other capital items be determined. The irrigation project may require capital investment on each farm to take advantage of the irrigation water to be provided.

Levels of Production: It is essential to determine the yield per hectare for the present vegetable grower. Farmers, technicians, and merchants can supply primary and secondary data that may be useful.

Farm Gate Prices for Produce: Farm gate prices for vegetables will be needed for farm-level analysis. This information can be received by interviewing farmers, traders, and merchants in the area. Seasonal prices and price differences for various qualities must be considered.

Diminishing Physical and Economic Returns -

It determines the economic level of all production practices.

- What yield of rice should a farmer strive for
- How much irrigation water should he use
- How much labor should he use

The fixed factor usually is land. Variable factors are labor, water, seed, and fertilizer. Diminishing returns come about from the physical relationship of variables to fixed factors.

Diminishing economic returns come about as the diminishing physical returns are translated into money terms.

Principle:	Add the variable resource to the fixed resource as long as the added return is greater than the added cost.

Substitution -

Since there are many technical possibilities of production, a farmer must choose the most economical method, measured in whatever terms suit his conditions in terms of physical labor, time, or money.

For example -- a farmer can prepare a seedbed himself with hand tools. He can hire labor, use draft animals, or a small or large tractor. He will need to consider the physical performance of each production factor and the cost of each.

The substitution of inputs may be viewed as follows:

a. An either or situation (perfect substitutes) -- if animal versus tractor power; artificial breeding of cows versus use of bulls; use of high yield varieties versus traditional varieties of rice.

b. Input mix (a partial substitute) -- use of varying combinations of (N) nitrogen - (P) phosphorus, and (K) potash; a low protein feed ration versus a high protein feed ration.

> The principle is this: In substituting one method for another, be certain that the savings in the method replaced is greater than the cost of the technique added.

Principles of Farm Costs -

It is important to understand and appreciate the role of farm costs since each farmer has some control over the costs of production on his farm but normally has little or no control over the prices he received for his products as they are determined by country-wide or worldwide factors. In order to make greater profits, a farmer must attempt to reduce his costs.

Two Types of Costs -- Fixed and Variable

Fixed costs remain the same regardless of the volume of production. Examples of fixed costs are cash rents, generally determined by the quality of the land. They are the same whether or not the farmer has a good crop or a poor one. Labor costs may be fixed and the cost of maintaining irrigation canals remain the same for a good or poor crop. Machine costs are often fixed, such as the annual fixed cost of owning a tractor.

Variable costs are those which change proportionally as output changes. They occur only if something is produced and do not occur if nothing is produced.

Fuel cost for a tractor will depend on acres farmed. If nothing is produced then labor costs or machine costs for harvesting may be zero. However, at harvest time the farmer must consider all cost incurred to that point as fixed as there is no way to recover the labor and money which has been spent so far. Now he must decide if the crop will cover his variable harvesting cost -- that of labor and machine costs.

It is also important for the project analyst to recognize over an extended period of time all costs become variable -- that is the farm size can be changed or more irrigation wells can be drilled over a period of several years.

Opportunity Cost -

Opportunity cost is an important concept when a choice of alternatives is considered on a farm.

> Opportunity cost simply means that the cost of using a resource is sometimes best measured, not directly in money or hours or something else, but in terms of the value of what was given up in order to undertake another choice.

For example, if a farmer earned $75 on a field of rice, the opportunity cost is the $75 profit he had to give up had the field been planted in vegetables. In either case he makes money, but the significance here is that each unit of land, labor, and capital should be used where it will add most to income.

4. Some Operational Methods for Predicting How the Project Will Affect the Typical Farmer

This is a key step in analysis of a development project at the farm level. At this point one must determine the effect of the project on the typical farmer.

In order to accomplish this, you may want to use the following tools:

- The complete farm budget
- The partial budget

These two tools of analysis are defined and discussed below.

- Farm budgeting can serve as a decision making tool: The farm budget is a physical and financial plan for the operation of a farm during a given period of time. The farm budget can be a useful tool which will help farmers to reach decisions on specific actions and changes in their farming operations.

  Budgets allow one to compare different ways to organize farms. To compare the returns of tomatoes or wheat, or dryland farming with irrigated farming. Budgets are a tool to look into the future and estimate costs, profits, and returns from farming.

  There are two types of budgets that can be used to look forward -- total farm budget and partial budget.

- Total farm budget: First let's discuss the total farm budget. It is used when total reorganization of the farm is anticipated, such as switching to irrigation or completely by changing the cropping patterns. The following information is required:

Inventory of resources available: We previously discussed the collection of data on capital, land, and labor available on a farm -- this is basic information for budgeting.

Estimate of future receipts: Present and future production need to be estimated. Technically possible (research results) and present farm yield levels need to be considered. An estimate of future yields considering the expected level of management on this farm needs to be determined. Prices, present and future, need to be determined.

Estimate of future costs: Records of present costs will be useful in determining a starting point, however future costs must be estimated from the budget. This will include variable and fixed costs.

Estimate of future returns: By subtracting future costs from future returns, one finds an estimate of returns. This income statement on the typical pattern farm is a starting point from which future changes and alternative combinations can be computed.

The total farm budget deals with all aspects of the farm operation -- total costs and returns. It is most useful when a project has widespread effects on the farmer's practices and system but rather cumbersome when only limited parts of the farm operation is affected.

- Partial budget: A partial budget may be described as one which presents in physical and financial terms the effects of making a specific change in the farming operation, however other operations on the farm remain unchanged.

  The partial budget is a tool often used to make an analysis of a change in farming operation or the adoption of new or additional technology, equipment, or structures which affect only a segment of the total farm business. An example: "Will it pay to add an irrigation system or should I raise soybeans rather than corn?" An analysis of a problem of this type deals only with the cost and return items that change as a result of the adjustment (and not with total costs and total returns).

  The term "partial" does not mean that it is incomplete or inaccurate. It is called partial because it deals only with parts of the business which would change as a result of some contemplated action. When a farm manager analyzes his problem, he follows a logical course of thinking about the changes -- more costs, added returns, more work -- that will take place if he expands his operation. Again, the partial budget includes

FOUR BASIC RELATIONSHIPS THAT CONTROL FARM RETURNS

Managers should recognize four distinct economic relationships to make sound decisions concerning their farming operations.

1. Factor -- Product relationships has to do with choosing the several farm resources to use in producing a particular product. This relationship concerns, for example, the amounts of labor, fertilizer, and other inputs to combine with land in producing an agricultural product.

2. Factor -- Factor relationship is concerned with choosing factors (inputs) to use to produce a given quantity of product. Choosing between using hand labor or combines to harvest a rice crop is an example of this relationship.

3. Product -- Product relationships are concerned with whether a farmer decides to produce rice or vegetables to make the most profitable use of his land, or some combination of both crops. He must choose among the products.

4. Time is the fourth relationship. This involves the time between the date the manager commits capital to, say, an irrigation system and that later date when this capital investment returns the physical production and cash revenue out of which the manager must obtain the funds to replace the original outlays.

Each of the preceding relationships is based on physical or technical facts, but requires price and cost information in order to make economic interpretations.

3. Some Basic Principles of Farm Management

It is useful to review some basic principles of farm management to provide a perspective of what are likely to be the on farm adjustments in response to capital development projects.

Comparative Advantage -

Explains the location of agricultural production -- it means that crops and livestock with differing requirements should be raised in those areas where physical and other resources are relatively best suited for their production. Since production possibilities are so numerous, the principle applies on a worldwide basis, country-wide basis, and on a farm basis.

Do not assume producing areas maintain the same economic relationships -- factors can and do alter comparative advantage -- most important are:

a. New techniques such as crop varieties and fertilizer

b. Changes in prices and availability of off-farm inputs such as insecticides

c. Changes in market demand and prices for individual products

d. Reduction in transportation costs

e. Land improvement such as drainage irrigation; thus, an area may improve or lose its economic position with respect to a given crop.

It is the job of the project analyst to develop new cropping plans and farm organizations to meet changing situations that are brought about by the capital expenditure on projects.

> In summary, the principle of comparative advantage is that agricultural crops and livestock have differing requirements and should be produced where the physical and economic factors are best suited for their production.

only costs and receipts which change, and it avoids the extra task of determining them for the entire business when it is unnecessary to do so.

Each part of the budget outline has a definite function and meaning. A basic concept is that any change or adjustment must affect the finances of the business in any one or all of the four ways which correspond to the four parts of the partial budget. Skillful use of this tool depends a great deal on an understanding of how each part works.

The parts of a partial budget are listed below:

1. Added costs - This part of the budget includes all new costs that are incurred as a result of contemplated changes in the business.

2. Reduced receipts - Receipts (sales) that are reduced or eliminated are recorded in this part of the budget.

3. Total added costs and reduced receipts - Because an added cost and a reduced receipt have the same effect on net income, we can add them. In effect, both are costs since they have a negative effect on net income.

4. Added receipts - This category includes all new receipts that would be added as a result of the contemplated change in the business.

5. Reduced costs - There may be other adjustments which would result in reduced cost. An example would be when changing from dairy to field crops. This would give numerous reduced costs on disposable diary equipment no longer needed in the business and the cost of discontinued forage crops.

6. Total added receipts and reduced costs - These two have the same positive effect on net income, therefore, are totaled as one. When the total of added cost and reduced receipts is subtracted from this total, the difference shows the gain or loss (change) in net income.

Using the Partial Budget With a Gro-more Pattern Farm

A survey of the Gro-more area determined that the typical small farmer grew about one hectare of grain sorghum during the dry season. It is assumed that with irrigation these farmers would grow cabbages on this hectare of land. A partial budget for the change follows:

Partial Budget for a Typical Gro-more Farm

Changing from one hectare grain sorghum (dry land farmed) to one hectare of cabbage with irrigation.

Additional Receipts		
7,500 cabbages (75,000 lbs. @ 2¢/lb)...	$1,500.00	
Reduced Costs		
Grain sorghum seed, fertilizer ...	60.00	
Harvesting costs for grain sorghum ...	30.00	
Planting, weeding costs ...	20.00	
Additional receipts plus reduced costs		+ $1,610.00
Additional Costs		
Cabbage seed, insecticides, fertilizers.	100.00	
Planting weeding, harvesting cabbage, and irrigation water ...	200.00	
Reduced Receipts		
Grain sorghum 10,000 lbs. @ 04¢/lb. ...	400.00	
Additional costs plus reduced receipts		- $ 700.00
Difference		+ $ 910.00

Therefore the shift to cabbage is profitable.

5. Are Farmers Able to "Go" With the Project?

When one is analyzing a proposed agricultural project, he may determine that it is expected to increase food production and that the benefits to society will be considerable. However, one key element must be considered -- will the farmer benefit enough so that he is able or willing to participate in the project? Several possible problems need to be considered.

Are the benefits adequate for the farmer to repay his investment? Are the benefits great enough to repay the principle and pay the interest on this investment?

Will the case income on benefits be received in a timely manner? The farmer must have cash for family living expenses and school fees, and he must have funds to repay his investment. Will it be several years before the project starts to produce and yield benefits to cover the above requirements?

Is the repayment schedule too tight? Should there be several years after initiating a project before repayment schedule is initiated? What will a crop failure do to farmer repayment schedule? What about lower prices for the farm product -- how will this affect the farmer's income and his loan repayments?

Additional Facts Needed

Pre-project Financial Statement: Determine farmer's present financial position. This can be done through interviews -- what he owns, cash on hand, and his liabilities.

Costs Through Project Life: The expenditure required for initial operation of the project, such as lateral canals to distribute irrigation water, maintenance costs of these canals, and other project costs throughout the life of the project is necessary information.

Family Subsistence Needs: Determine the subsistence needs of the family. Can, and does, he produce most of these needs on his farm? The analyst must remember that this production requires land, labor, and capital and it should be considered in budgeting. What are the cash needs of the family?

Other Income Sources and Obligations: One should determine if the typical farmer has an off-farm job that meets some of his subsistence and cash needs. What are the traditional obligations such as weddings that also must be met.

Repayment Schedule as Proposed: It is important to review the repayment schedule as originally proposed for the individual farms and for the project as a whole.

Prior to the start of the project it is necessary to review all expected costs and returns and the timeliness of these costs and returns. It may be appropriate to redesign the project to insure its success. Possible changes that might be considered are:

Longer Repayment Schedule or Repayment "Holiday": A delay in the initial farmer repayments for four or five years may be one method of improving the timing of the expenditures and benefits in the project. Another method may be lengthening the farmer's loans from 10 to 15 years to reduce the annual repayment amount.

Lower Input Prices: If, after calculating the cost and benefits associated with this project, it appears that the farmers will not make a sufficient return to provide the incentive to participate, then one may opt to adjust the terms of trade for the farmers. One often used method is to subsidize the cost of inputs It may be appropriate to subsidize the cost of construction of irrigation canals, or cost of irrigation water, or cost of fertilizer. That is, the government will arrange for the farmer to pay less than full cost for these inputs, thus increase his returns from farming.

Higher Output (Product) Prices: If the farmer's costs and benefits are determined as such that the profit incentive for participation is lacking, then one may study the output price level. It is possible that improved quality of product or increased marketing efficiency will increase the product price paid to the farmer. It may be that the government may wish to establish some type of subsidy to increase the farmer's product prices. Since these types of subsidy programs can become very costly, they will need to receive very careful consideration before action is taken.

6. Aggregating Farm Responses to Project Levels

Once the benefits have been determined per hectare or per farm it would seem a simple matter to expand this information to the project level and to determine gross benefits. NOT SO! There are still many problems that need to be considered. These problems are often called "slippages". Some reasons for slippages are:

Not all farmers will adopt the new methods: In our Gro-more vegetable irrigation project one may find that all farmers will not want to irrigate because of increased costs and labor.

Inaccurate yield assumptions: Some farmers' yields may fall well below the expected yields.

Failure to consider subsistence crops: Traditional farmers produce subsistence crops for a family food supply. They will probably continue to produce this subsistence crop on some of their land even though they could produce a higher value new crop.

Inadequate harvesting and storage methods: Sometimes traditional farmers do not know how or cannot efficiently harvest and store a new crop. These harvesting and storage losses should be considered.

Allowances for the above losses or slippages should be reflected or partially reflected in the data developed on farm level benefits. However, they are so often omitted or not given adequate consideration that they are again emphasized.

7. Some Considerations in Getting Needed Facts

Review of Survey and Sampling Methods: It is appropriate to review the various sampling methods that might be used to select a group of farmers for interviews in collecting the data for the pattern, or typical, farm in the Gro-more project.

Simple random sampling from a finite population (a limited universe) is a method of simple selection that gives each possible sample combination an equal probability of being chosen. (It is not haphazard selection but positive controls insure that each possible combination of equal probability of being chosen.)

Stratified random sampling recognizes the existence of different classes, or strata, in the population, and attempts to secure a representativeness by dividing the population into more homogeneous segments than the aggregate, selecting items at random from each of these strata, and combining them to form one total sample. In other words, a sample is selected from each of the classes. An example of different classes on strata might be small farms, and large farms.

By summarizing and weighting these individual stratum estimates, an aggregate sample estimate is obtained that will be more consistent than a total or average figure obtained from an equally large unrestricted sample, because of the insured representation of all different elements.

With stratified random sampling, the population is divided into a number of mutually exclusive subpopulation groups, each of which is sampled independently. The results of these independent samples are then combined to provide the derived estimate for the entire population.

If a comprehensive and up-to-date list of farmers does not exist as required to select a stratified random sample, then one may consider the area sampling approach. In this case, a reconnaissance survey on all farms in the area should be conducted covering only a few items, such as size, tenure, and type of land to compile a complete list of all farms. After compiling a list of all the farmers in the area the next step is to classify them into various groups according to pre-determined characteristics. These criteria might be soil type, farm size, or tenure. Then from this stratified list a random sample from each group list is selected.

Proportionate stratified sampling may also increase the accuracy of the sample if the difference between the various classes or strata is great. It may be important to increase the sampling fraction of some of the classes.

Purposive or Quota Sample: This method is sometimes used in place of random to choose a so called "representative" sample. With this method, one would only select or ask someone in the field to select several representatives (average farmers to be interviewed). This is a rather easy method of selecting a sample, however it may not be an objective method.

Some of the disadvantages of this method are:

a. The purposive sample assumes that a sample has the same average characteristics as the population -- however, there is no assurance that this is true.

b. Much interviewer bias may be present as he may subjectively select a sample.

c. It is impossible to draw statistically sound conclusions from the sample. This is because each member of the population does not have an equal chance of being drawn -- only those members that bring the sample closer to the subjective "average".

Since there is no statistical theory for measuring the reliability of sample results by purposive or other nonrandom sampling methods, such methods are automatically excluded if the criteria of good sample design is to be followed.

The 50 Gro-more Vegetable Farmers

Upon closer examination of the farmers of the Gro-more area it was found that the agricultural office in the area had the following information:

2 Farmers had holdings of 100 hectares each

3 Farmers had holdings of 5 - 99 hectares each

45 Farmers had holdings of less than 5 hectares each'

Now one must determine what kind of a sample to use to determine the relevant data for the typical or pattern farm.

Remember, we discussed the following types of samples:

- Simple random sample
- Stratified random sample
- Proportionate stratified random sample
- Purposive or quota sample

Since two farmers have holdings of 100 hectares each, three farmers have holdings of less than five hectares each, what kind of a sampling method would be appropriate? A proportionate stratified random sample whereby all of the large and medium farmers are interviewed and a sample of the small farmers would be interviewed and surveyed is appropriate.

8. Analyzing the Nonincome Effects at the Farm Level

Authorities are placing increased emphasis on looking at the nonincome effects of development projects. This means to look at effects other than the financial and economic returns.

Increased Food Production: If a goal of your area is self-sufficiency in basic foodstuffs, then increased production may have a higher value than the world price for that commodity. It may also have humanitarian benefits if the area considered is remote and subject to crop failures and food shortages. Then an irrigation system might be a way to insure a more adequate food supply in this remote area.

Income Distribution Effects: A project that provides considerable employment for farm laborers or landless people may have a considerable positive effect in providing additional income for the very poor of a society.

Improved Nutrition: A project designed to provide additional protein to people living in an area where protein shortages are serious will certainly have nonincome effects that are difficult to measure. Improved health of the children may be a major benefit as a result of the additional protein.

Additional Readings

Bishop and Toussaint, Introduction to Agricultural Economic Analysis, New York, John Wiley & Sons, Inc., 1958, pp. 20-28 and 68-81.

Gittinger, J. P., Economic Analysis of Agricultural Projects, The Johns Hopkins University Press, 1972, pp. 1-30 and 130-155.

Heady and Jensen, Farm Management Economics, Englewood Cliffs, N.J., Prentice-Hall, Inc., 1954, pp. 54-119.

Stanton, Bernard F., Farm Budgeting for Project Analysis, Economic Development Institute, IBRD, 1973, pp. 51-75.

Stevens, George, Forward Budgeting, Agri-Economics, College Park, Md., University of Maryland, February, 1964.

Yang, W. Y., Methods of Farm Management Investigations (Revised Edition), FAO Agricultural Development Paper No. 80, Rome, Italy, 1965

Some Questions for Thought and Discussion

1) The Gro-More example assumes that all 50 Farmers in the area will grow irrigated vegetables. Is this a realistic assumption? Explain why you think it is or is not.

2) On page B-11, the costs and benefits of this project are listed. Included is a $600 labor charge. However, upon your survey of the Gro-More area it is found that there is considerable unemployment among the young men in the farmers' families. Do you think any adjustment is appropriate for the labor costs? If so, why?

3) In the Partial Budget on page E-12, it was assumed the typical Gro-More farmer could sell his cabbages at 2¢ per pound. Recompute this budget assuming that the additional supply of cabbages has caused the farm price to drop to 1¢ per pound. Do you think this might happen in a project like this one?

4) During the survey of the Gro-More Farmers it was noted that the people were suffering from a severe protein shortage in their diet. Upon further discussion with Health Experts and others, a proposal was developed that a poultry growing project would be of more benefit than a vegetable growing project. The Health Experts suggest that all the poultry be consumed by the Farmers. Your survey indicates that there is little or no market for poultry products in Gro-More town or Grand Center City. As systematically as you can, list the pros and cons of this proposal.

5) On Page E-3, it was explained that farmers have five basic kinds of decisions to make - 1)What to produce, 2)What production methods to use, 3)How much to produce, 4)When to buy and sell, and 5)Where to buy and sell. Thinking of the Gro-More vegetable farmers, what are some examples of alternatives in each of these five categories that might be relevant for them to consider?

6) Suppose that it is now five years later and that the Gro-More vegetable irrigation project has been implemented. However, the results have fallen far short of the original expectations. Only 25 farmers shifted to irrigation. Those who did had gains in vegetable sales of only $2,000 a year. The FA found that the water fees it charged did not cover its cost. What are some things that would have gone wrong?

Practice Exercise

Suppose that you are a project analyst in the Minister of Agriculture's Office of Gro-More Nation. The Minister has to approve all capital investment projects, like the Vegetable Irrigation Scheme proposed by the Gro-More FA. The Minister raises some questions about the estimated impacts (benefits and costs) on the Gro-More farmers. He is wondering a) whether the projected changes in farmer income and costs are realistic; b) whether likely future changes in prices are adequately taken into account; c) whether all vegetable farmers are likely to go into the project; d) whether irrigation is the best change that the farmers could make to increase their income; and e) whether there are other, non-income considerations on the minds of the farmers which need to be taken into account. He asks you to head a 4-man team to supply this information in three weeks' time.

Outline in some detail a plan for obtaining and analyzing these facts. That is:

1) What specific facts or estimates would you need to obtain?

2) From whom would you get each of these facts?

3) How would you go about getting these facts? (For example, if a survey would be entailed, what specific questions would you ask, what sampling method would you use, etc.?)

4) What analytical framework would you use to bring this information in a form that would be useful and meaningful to the Minister of Agriculture?

(If there is more than one way to obtain the needed information, you may want to show the advantages and disadvantages of each.)

Some Ideas for Teaching Part E

1) It is important that the participants of the course gain insight to how a Capital Development Project might be viewed by farmers. To help set the stage for Part E, the movie, "A Future for RAM" by Phillips Foster, the University of Maryland, 1967, might be used. This 28-minute movie depicts the problems of a small Indian farmer trying to take advantage of a Government program to provide credit, new seed and fertilizer to increase wheat production.

2) These notes serve to "warm up" participant attention to the collection of data and farm-level analyses that go into a project proposal. But the practical techniques and problems involved are not likely to come to life unless they are given an opportunity in the course to gain actual practice in conducting a survey and preparing farm budgets. To do this, it has been found effective to take project analysis classes to the site of an actual project for several days, where their task is to identify, collect and analyze the detailed facts needed to evaluate that project. If it is large and complex, it is probably best to deal with only one, fairly simple aspect of the case project. The focus could be either on analysis of project components already implemented or on a new component proposed for the future. Providing actual experience in designing a questionnaire, selecting a sample, conducting farmer interviews, and tabulating the results is an important part of such an exercise.

SELECTED DEFINITIONS

BENEFIT COST RATIOS	$\frac{\text{Present worth of benefits}}{\text{Present worth of costs}}$
	$BCR_{all} = \frac{\text{Present worth of gross benefits}}{\text{Present worth of gross costs}}$
	$BCR_{inv} = \frac{\text{Present worth of gross benefits less costs other than investment costs}}{\text{Present worth of investment costs}}$
CASH FLOW	Gross incremental benefits less gross incremental costs.
DISCOUNT FACTOR	"How much 1 at a future date is worth today" at the selected discount rate.
DISCOUNTING	"Process of finding the present worth of" a flow of money in future years.
DISCOUNT RATE	"The interest rate assumed for discounting."
ECONOMIC ANALYSIS	Analysis from the viewpoint of the whole society or economy.
FINANCIAL ANALYSIS	Analysis from the viewpoint of entities which participate in projects such as farmers, businessmen, and public agencies.
GROSS BENEFITS	Total value of project production of goods and services.
GROSS COSTS	Total costs of project including investment costs, as well as other costs often referred to as operating costs.
GROSS INCREMENTAL BENEFITS	Gross benefits with the project less gross benefits without the project.
GROSS INCREMENTAL COSTS	Gross costs with the project less gross costs without the project.

INTERNAL ECONOMIC RETURN	Internal rate of return used in economic analysis.
INTERNAL FINANCIAL RETURN	Internal rate of return used in financial analysis.
INTERNAL RATE OF RETURN (IRR)	"That discount rate which just makes the net present worth of the cash flow equal zero."
NET BENEFIT	Same as cash flow.
NET PRESENT WORTH	"Present worth of the cash flow stream" of money.
OPPORTUNITY COST	The cost of using a resource sometimes is best measured, not directly in money or hours or something else, but in terms of the value of what was given up in order to undertake another choice.
PRESENT WORTH	Value at the present of a flow of money in future years.
SHADOW PRICE	That price which would prevail in the economy if it were in equilibrium under conditions of perfect competition.
TRADE OFF	What one gives up with respect to one project objective in order to gain more for another project objective.
SLIPPAGE	Is the difference between technical possibilities and the real on-farm results.