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ECONOMIC APPRAISAL OF LAND AND WATER RESOURCE
PROJECTS IN LESS DEVELOPED COUNTRIES

By

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A THESIS

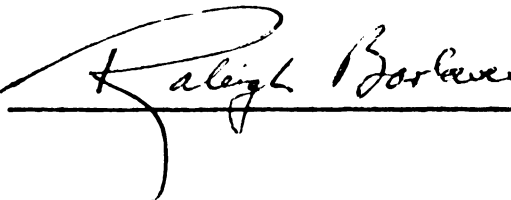
Submitted to the School for Advanced Graduate Studies of
Michigan State University of Agriculture and
Applied Science in partial fulfillment of
the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1965

Approved



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Expanded demands for economic and social progress in less developed countries are reflected in increased water resource developments. Evaluation of agricultural, economic and administrative aspects of many projects are frequently inadequate for support of loans from financing agencies. Results vary widely due to differences in criteria used to appraise projects. Since criteria for evaluation in less developed countries are lacking, practices established in the United States are uncritically used which frequently are not applicable to existing socio-economic conditions.

Obstacles to project evaluation and resource development in less developed countries are more numerous and complex than in this country. Principal obstacles are associated with paucity of data and serious human and institutional factors. Evaluation procedures must be adjusted on a project basis to reflect the national environment of each society, and the encrusted practices in agriculture, religious beliefs, education and traditions of the people.

This treatise has indicated the differences in the evaluation procedures and criteria used by United States agencies and their implication on the economic feasibility of projects. A conceptual framework was developed which is believed to be more adaptable to evaluation of projects in less developed countries and, in general, elsewhere.

The principles of evaluation were related to project studies in West Pakistan, Guinea and Uruguay. This provided a wide range in physical, economic and institutional problems which are believed to be applicable to less developed areas elsewhere.

Evaluation techniques used by Federal agencies vary significantly in

basic concepts, measurement standards, and comparability of benefits and costs. The fate of a project may be determined by evaluation techniques acceptable to one agency but not another. Similarly, differences in financing requirements by loaning agencies allows a project to be feasible for one agency but not another.

The best criterion for determining project justification becomes an academic question if the sole criterion is merely to satisfy the legal requirement that net benefits exceed costs. The net benefit criterion is unsatisfactory if it is desirable to rank projects in optimal order. Ranking by the rate of return criterion is preferred since it ensures that the present value of available resources is maximized. It has the advantage also that the computed return is the maximum interest rate which leaves the project barely justified.

Benefits from water resource projects can be estimated conceptually as consumer surplus, and alternative costs are reasonable approximations of gain in consumer surplus.

The objective of maximizing economic efficiency, inherent in United States standards, is secondary to welfare objectives in less developed countries. Secondary benefits, therefore, should be given greater emphasis in determining project feasibility.

Characteristics of rural societies in less developed countries require modification of evaluation procedures. Most obstacles to evaluation can be overcome by adoption of short-cut methods of procedure, from experiences on existing projects, and from informed judgment of well-trained project investigators.

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CHAPTER I

INTRODUCTION

The Problem

Since World War II the demand for economic progress and social improvement in the less developed countries has increased steadily. Many countries in the Middle East, Africa, Latin America and elsewhere have embarked on various types of investment programs for economic development as means towards attaining more efficient use of human and natural resources and higher levels of living for their people. Since agriculture is the largest sector in the economy of these countries and provides the base upon which the industrial and other economic superstructure must be built, agricultural improvement receives considerable emphasis. Large-scale programs have been undertaken for increasing farm production by such methods as expansion of irrigation and related water resource developments, drainage, increased use of fertilizers, plant protection, improved seed and plants, mechanization, land reform and agricultural extension services.

This expansion in agricultural improvement and resource development in the less developed countries is made possible by financial and technical assistance largely from Western countries. The United States has taken the lead in this activity and has done more than any other country in contributing to relief, rehabilitation, reconstruction and economic development in foreign lands. Before 1954, most of the aid from the

United States went to Europe. Since then it has gone to less developed areas of the world.

This study is concerned with that portion of the financial aid loaned to these countries for financing water resource projects. The principal agencies providing loans for this purpose are; (1) the Export-Import Bank, (2) the United States Agency for International Development (USAID), (3) the International Monetary Fund, (4) the International Bank for Reconstruction and Development (IBRD), (5) the International Development Association (affiliate of the IBRD), (6) the International Finance Corporation, (7) the Inter-American Development Bank (IDB), and (8) the Inter-American Social Program Trust Fund (administered by the IDB). Both technical and financial assistance is available also from the Food and Agriculture Organization (FAO), and Special Fund projects administered by the United Nations.

Within limits of the legal, financial and administrative regulations of these financing agencies, projects for which loans are granted must be economically and financially feasible. The feasibility studies may be prepared by a government agency of the borrowing country but because of lack of technically trained personnel most of them are actually prepared by consultants. Legal provisions governing the Export-Import Bank and USAID require that consulting services be procured from the United States. The other agencies require only that the consulting services be procured from member nations of the respective agency; however, a high portion of these are also prepared by consultants from the United States.

The quality of the feasibility studies presented to the financing agencies in support of loans to borrowing countries are rated generally as being poor. Personal interviews with officials of the IBRD, for

instance, revealed that in no case were they satisfied with the evaluation of the agricultural, economic and administrative aspects of the project reports that the Bank had received. The general consensus of opinion expressed by officials of the other agencies revealed that in the majority of cases the treatment of these phases of project investigations was also seriously inadequate. It was indicated also from these interviews that there was wide variation in the procedures and criteria used in evaluating resource projects, which made the appraisal of potential projects difficult and comparisons among projects almost meaningless.

Numerous requests for loans have been refused because of inadequate coverage and, in some instances, improper application of evaluation procedures. This has resulted in some worthy and badly needed projects being delayed; additional costs being incurred for pre-construction investigation which most of the countries can not afford; and, in some instances, has created bitterness and ill feelings between the financing agency and the borrowing country. This situation has tended to undermine the effectiveness and purpose of the entire assistance program.

Questions arise as to why the nonengineering aspects of project investigations in the less developed countries are so poorly covered. Why do results of feasibility studies vary so widely? What are the reasons for such wide variation in the methods and criteria used to evaluate the feasibility of potential projects? What improvements can be made in the procedures to upgrade the quality of the feasibility studies? Answers to such questions are of particular concern to the financing agencies, to the consultants engaged in project planning and investigation and, of course, to the government agencies responsible for water resource

development.

If the assistance programs are to effectively accomplish the objectives for which they were designed, it is imperative that improvements be made. Though there may be many ways in which improvements can be made, two obvious ways appear to be by; (1) improved standards and quality of work by the project planners and investigators, and (2) adoption of more appropriate procedures and criteria by the financing agencies for appraising potential projects.

Economists responsible for the feasibility studies face a tremendous challenge in evaluating projects in the less developed countries. The obstacles and problems faced are generally more numerous and, in many respects, more complex than those normally encountered in this country. Seldom are there reliable statistics from which to assess the present agricultural situation and production of the project area, or the production of similar areas already developed under irrigation. It is unusual for there to be adequate or reliable data regarding soils, agronomy, water duties and production statistics. It is most exceptional to find any worthwhile information concerning the economics of farm production. Finally, and perhaps most important, there are usually serious human and institutional obstacles which complicate the evaluation processes. These problems must be solved or, at least, greatly reduced if reasonable standards of agricultural production and project analyses are to be attained.

Apart from institutional problems and paucity of data, economic conditions in these countries are vastly different. For instance, there is frequently serious imbalances in resource use. Underemployed resources usually include unskilled labor and often, land and water, but know-how,

managerial experience and capital are usually scarce resources.

Proper evaluation of projects in these countries requires that the obstacles to economic development be recognized and clearly understood. Because the obstacles are frequently unlike those encountered by economists in this country, naive application of highly developed tools of economics often yield results that are largely irrelevant and not applicable within the political and institutional environments of the less-developed country.

The investigator must understand that values and goals of other people are different and application of economic criteria and procedures developed in the United States are not always the only techniques or even the best means for evaluation of projects in other societies. A clear understanding of the development problems and economic conditions within a country is essential to the appraisal of proposed projects; careful definition of the objectives and the procedures for the investigation, and recognition of the means available for operation of a project must be understood by both the project investigators and the financing agencies.

The procedures and criteria that can be used effectively in the less developed countries for evaluation of projects are still in a state of infancy as compared with those available for use in this country. Consequently, the financing agencies, the consultants and the technicians of the borrowing countries look to the United States for acceptable standards with which to evaluate potential projects. However, in spite of the high professional level of the procedures available, there are wide variations and inconsistencies in the methods and procedures actually used by the various United States government agencies. These variations and

inconsistencies are reflected in the project studies made in foreign countries. The procedures and criteria used reflect not only the variations and differences noted among United States agencies, but also of those of individual investigators. Further, feasibility studies are frequently prepared by foreign consultants who also have their own procedures for evaluation. This contributes further to the inconsistencies and variations among the studies submitted for financing.

The variations in evaluation procedures among the water resource planning agencies in the United States are a reflection partly of basic differences in concepts, measurement methods and standards and in comparability of benefits and cost estimates. Certain of the difficulties result from legal and administrative provisions applicable to particular programs, some have grown out of difficulties inherent in practical application, but a large portion results from the absence of an adequate framework of concepts and principles. Aside from these causes of differences, a fairly substantial gap often exists between prescribed practices and those actually applied in the analysis of particular projects. There are needs for determining the similarities and dissimilarities in the criteria and evaluation practices among the United States agencies in order to gain an understanding of the impact of these practices on project feasibility; to suggest alternative recommendations for improvement; and to develop a consistent set of criteria and standards which may be applicable for evaluation of projects in less developed countries.

The criteria and measurement standards adopted by the United States resource planning agencies are used also by the international financing agencies to review and appraise feasibility studies of projects in less

developed countries. The USAID, for example, has adopted procedures recommended in the recently issued Senate Document 97.¹ Provisions of this document are essentially the same as recommended by the "Green Book",² and by the United States Bureau of the Budget A-47. The other agencies look to these references as guides in appraising feasibility studies, although formal statements specifying precise criteria and standards for use by consultants in preparing reports are not issued as is the case with USAID. But, differences in legal, financial and administrative regulations of these agencies contribute to the confusion and variations in procedures used by the consultants to evaluate projects, particularly with respect to financial feasibility. Seldom does a borrowing country know prior to completion of a feasibility study which agency may be receptive to financing the project; and, obviously, the financial feasibility of a project is affected by the terms required for financing. There is a need not only for uniform procedures for the appraisal and review of the economic feasibility of projects but also for terms of financing, particularly for similar types of projects.

As mentioned previously, application of rigorous standards and sophisticated economic tools developed in the United States, such as

¹Statement of "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans For Use and Development of Water and Related Land Resources", prepared by Sub-committee of the Secretaries of Interior, Agriculture, Health, Education and Welfare; and the Secretary of the Army.

²The "Green Back" is the Inter-Agency Subcommittee statement on Proposed Practices for Evaluation of River Basin Projects, 1950, Revised 1958.

those specified by USAID and contained in Senate Document 97 are often unrealistic and impractical for evaluating projects in the less developed countries. Under some conditions it is unrealistic to apply more than rather crude tests of economic feasibility. Even the most reliable data from these countries that can reasonably be expected do not warrant involved economic techniques because of vastly different types of agriculture organization, institutional arrangements, economic systems and social goals for economic development.

Some quantitative assessment of direct economic benefits from a project, however, must be made. For this purpose, short-cut methods are needed which will give economic results sufficiently accurate to meet the basic requirements of the financing agencies, and to serve the needs of the project planners. But there is a minimum amount of data from which reasonably sound judgments can be made and short-cut methods applied. It is imperative, therefore, that the project investigators have a clear understanding of the extent and type of data that is absolutely necessary to evaluate the economic feasibility of a potential project.

Objectives of Study

The increased role of the United States in providing technical and financial assistance for water resource development in less developed countries offers many challenges, responsibilities and opportunities for agricultural economists and other agricultural technicians. It is stated that the quality of our past performance in evaluating the nonengineering aspects of potential projects in these countries has been rather poor. The overall objective of this study is to evaluate alternative criteria

and procedures for evaluation of water resource projects, and to suggest additional methods for estimating project benefits and costs under the various physical, institutional and economic conditions commonly encountered in less developed countries. This objective will be accomplished in several phases:

(1) The first phase will include a review of the evaluation procedures and criteria used by major federal water resource development agencies of the United States. The similarities and dissimilarities in these procedures will be noted and implications of these differences on the economic feasibility of projects will be determined.

(2) The second phase will be to consider the economic logic of the evaluation criteria in an effort to provide a basis for recommendations for improvement of the conceptual framework for evaluation of water resource projects. Alternative criteria and procedures will be advanced which are believed to be more adaptable to project evaluation in less developed countries.

(3) The third phase will be to identify the principal obstacles to project evaluation in three less developed countries. Just as no two projects are alike, neither are the physical, institutional and economic conditions of two countries alike. It will be demonstrated that differences in these conditions oft times require new or modified procedures if reasonable analyses are made of potential projects. Short-cut methods will be developed which may be used to obtain reasonable estimates of project benefits in situations where highly developed procedures are not applicable and where sufficient information for detailed studies are lacking.

(4) The fourth phase will be to indicate both the minimum amount and the type of data from which one can reasonably expect to perform a feasibility study. This will represent the minimum data from which reasonably sound judgments can be made, and from which the principles of project appraisal can be adapted to adverse situations normally encountered in most less developed countries.

Procedure

The method of this study was to inventory and analyze all available research and empirical studies on resource evaluation and to relate the fundamental concepts and principles to the analysis of projects in three less developed countries. The work was organized into two parts, the first involving research and study of the publications of the United States government water resource agencies, and of professional articles and research works by prominent land economists. Past experiences in resource evaluation work with the Bureau of Reclamation, experience as an assistant professor in land economics, and experience as a consultant on economic investigations in numerous foreign countries has served as valuable background for development of evaluation concepts and methods.³

The second part of the study relates the principles and concepts of project evaluation, as developed in the first part, to specific projects that were investigated in Guinea, Uruguay and West Pakistan. The

³Agricultural Economist with Bureau of Reclamation from 1943 to 1953, Assistant Professor at Utah State University from 1955 to 1962, and Head, Agricultural Planning Department of Harza Engineering Company from 1962 to present.

data used for this study were obtained in connection with engineering and economic feasibility studies made in these countries while employed with a private consulting engineering firm. Though some of the basic data used in this study are presented in feasibility reports completed on these projects, this research report represents additional work not related to services provided as a consultant with this engineering firm.

This study was commenced in 1962. Data concerning evaluation criteria and procedures were collected from the libraries of Utah State University and the University of Chicago in the early part of 1962. Contacts were made at various times during 1962-64 with officials of the IBRD, USAID, and other agencies concerning the general problems of project evaluation and financing in less developed countries. Discussions were held with officials of the United Nations, both the Special Fund Operations in New York and the FAO in Rome, during this same period.

Three countries, described as "less developed" by the financing agencies, were visited during the two year period, 1962 and 1963. Work on the project in Uruguay was conducted during April to July in 1962, in West Pakistan from January to March, 1963, and in Guinea from April to July, 1963. A water and land resource project was investigated in each of these countries.

These countries were selected for this study because a wide range of differences in physical, institutional and economic conditions were encountered. These conditions are discussed in detail in Chapter II. It was felt that the range and type of problems in resource evaluation on these projects would be sufficiently broad to be representative of typical situations found in most of the less developed areas of the world.

The implications and recommendations made in this study should have wide application to resource evaluations of other comparable projects.

Some major physical, institutional and economic conditions in the three countries studies are described briefly below. The detailed appraisal of specific factors and obstacles to evaluation of projects within these countries is presented in Chapter V.

The Study Areas

Guinea, West Africa --- Riceland Reclamation Projects

Location and Physical Conditions The Republic of Guinea is located on the Atlantic coast of the "Bulge of Africa" about 670 miles southeast of Dakar, Republic of Senegal. It extends from latitude 9° to 12.5° N and from longitude 17° to 12° W. The country is bounded by Portugese Guinea on the northwest, the Atlantic Ocean on the west, Sierra Leone on the southwest, Liberia on the south, the Republic of Ivory Coast on the southeast, and the Republic of Senegal and Mali on the north.

Investigations to determine the feasibility for development of rice Production were carried out along the coastal area of lower Guinea. The climatologic, physiographic and hydrologic characteristics of this area Play an important role in the successful exploitation of the land for rice Production. The rainfall is heavy, averaging about 112 inches per year. Most all of the rain falls during the period from May to November, and the number of rainy days as well as the amount of rain varies considerably from year to year.

The climate is hot, with high relative humidity, and with little variation in temperature throughout the year. The average maximum tem-

perature is 85° F. and the average minimum 75° F. Vegetative growth practically ceases during the December-April period because of complete lack of precipitation. Crop production is dependent entirely on natural precipitation and only one crop per year is possible without irrigation.

The relief of the coastal plain is cut deeply by old estuaries. During the dry season when surface run-off is practically non-existent, the estuaries become tidal inlets bordered by saline, muddy lands. Tidal variations extend far inland since the coastal plain is only a few meters above sea level. Because of low elevation, most lands that are potentially suitable for rice production are poorly drained during the wet season and subject to the influences of salt water during high tides. Crop production is seriously restricted due to these physical limitations. The plans for development of this project involves construction of drainage works to remove excess surface water, and structures to control flooding by seawater during high tide.

General Economic and Institutional Background Guinea became an autonomous republic in October, 1958 from the former territory of French Guinea. It has a population estimated at three million and is increasing at about three percent per year, putting continued pressure on available productive land.

Modern politics in Guinea re superimposed on a network of tribal relationships. A large majority of the population is Muslim. One-third belongs to the Foulah tribe, a Hamitic group with a feudalistic social organization; two-fifths are the Mandingo Negroes located mostly in the northeast, and about one-fifth the Soussau located mostly along the coast. The remaining population belongs to numerous small tribes.

Although intertribal antagonisms exist, the long-practiced French policy of demanding subservience from the chiefs, and the tactics followed by the independent Guinean government of including opposition chiefs in the Cabinet have weakened tribal leadership, and no serious internal friction is evident.

More pressing on the new government are the economic and administrative problems arising from the abrupt change-over from French to African rule, and the withdrawal of French technicians and administrators. Almost total illiteracy, estimated at 98 percent, and traditional antagonistic attitudes toward manual work outside of agriculture have hampered development of a stable, skilled African labor force. As artisans have customarily come from castes of a low social status, it is felt that working with metal and machinery is degrading. Also, work is still associated with memories of the forced labor resorted to by the French.

Despite excellent mining and industrial potentialities, Guinea is now a poor and underdeveloped country, with agriculture the mainstay of the economy. About 95 percent of the population is engaged in growing and processing agricultural products at the subsistence level. Subsistence agriculture satisfies the basic needs of the people living outside of the money economy but there are frequent and serious shortages of almost all foods in urban centers and on occasions in the rural areas. A variety of climates, generally fertile soil, and favorable topographical features, provide Guinea with a potential for considerable agricultural diversification and development. The country is not self-sufficient in basic foodstuffs and must import staples such as rice, wheat, flour, dried milk, and sugar. The major obstacles to agricultural development,

together with problems encountered in evaluating the economic and financial feasibility of potential projects are discussed in Chapter V.

Uruguay --- Zapucay Pilot Irrigation Project

Location and Physical Characteristics The Zapucay Irrigation Project is located in the Departments of Taucarembó and Riveria in the northern part of Uruguay, near the border of Brazil. The topography is smooth and rolling with small rounded hills, and with valleys of small rivers and streams. Like most of Uruguay, the project area is primarily a grass country with few trees so that the entire area can be cultivated or used as pasture.

Uruguay is the only Latin American country lying entirely in the Temperate Zone, although the climate approaches the sub-tropical in the northwest. The average annual rainfall in the project area varies between 42 and 56 inches and it is distributed relatively uniformly throughout the year. Extremes of temperature are from -8° to -24° F., and the frost-free period extends from about September 1 to May 1.

Despite average monthly rainfall that gives an impression of adequate moisture for production of most crops, there is frequent occurrence of long periods of drouth. Irrigation is not practiced at present but would be required for successful production of most cultivated crops, and would be beneficial to production of pasture and forage crops. The Zapucay Project was planned as a pilot-irrigation project to demonstrate the effects of irrigation on production; to stimulate introduction of diversified agriculture into the region; and to train farmers and project operators in modern techniques of irrigation.

Over 90 percent of the land in the area is used for grazing of

natural pastures. There has been no discernible change in land use during the past 100 years. The predominance of the livestock economy is so great that even though crop production is feasible in many instances there are frequent shortages of many foodstuff; particularly, fresh vegetables, fruit and truck crops. The sole supply of feed for livestock is from grazing and during the winter months and drouth periods the animals do not have adequate feed. The average age of beef at a market weight of about 1,000 pounds is over four years. There is a need for development of surplus forage for supplemental feeding when grass from natural pastures is not available.

Uruguay is one of the richest countries in the world in natural pastures but numerous problems related to farm organization, land tenure arrangements, government administration and other obstacles exist that keep the country at a low stage of economic development. These obstacles are discussed in detail in Chapter V.

General Economic and Institutional Background Though there has been no complete census in Uruguay since 1908, it is estimated that the population is around three million. This would make it the most densely populated country of South America, with about 35 persons per square mile. Over one-third of the population is concentrated in the Capital, Montevideo. Uruguay ranks as one of the top South American countries in education with the percentage of illiterates at less than 20 percent. The government is a democracy, suffrage for the citizens over 18 years of age is universal, secret and obligatory. Even though the government favors state ownership of many industries, most of the land is held in private ownership. Agrarian reform within the country is moving ahead slowly but

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through orderly legislation.

Uruguay is in a better economic and social position than most other Latin American countries. It is primarily a pastoral economy with little mineral wealth and with crop production of secondary importance. They have a freehold or private-ownership system of land tenure quite similar to that found in the United States, with laws and customs favoring the individual. An abundant supply of land together with liberal policies for distributing the land to private ownership in the country's early history contributed to the creation of large holdings. In the project area, for example, 8.5 percent of the owners hold over 80 percent of the land.

The large landowners constitute the most important economic, social and political group in Uruguay, with considerable prestige and influence. For the most part, however, these large "estancias" are not operated efficiently. The owners most often do not live on their ranches and their primary interests are in political or other economic endeavors in the urban centers.

One of the principal problems facing the Government of Uruguay is the large majority in the landless classes, sharecroppers and hired laborers in the rural areas. The advance to land ownership and increased economic well-being of most of these people is blocked by serious economic and institutional problems. These problems, as related to agricultural development and resource evaluation, are discussed in Chapter V.

West Pakistan — Tarbela Project (Indus Basin)

Location and Physical Characteristics West Pakistan occupies the western portion of the Indo-Pakistan subcontinent, between longitude

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61° and 75° east and latitudes 24° and 37° north. It is bounded on the west by Iran, on the northwest and north by Afghanistan, on the northeast by Gilgit Agency, Azad Kashmir and Jammu and Kashmir, on the east by India and on the south by the Arabian Sea.

The Indus Plains, the outstanding physical feature of the Province, contain one of the worlds' oldest and largest irrigation areas. Development started many centuries ago, and now includes more than 30 million acres under the command of numerous barrages and thousands of miles of irrigation canals. This irrigation system is unique in that such a large area is completely dependent for water supply upon unregulated natural river flows.

Although West Pakistan is situated entirely within the temperate zone, the climate is tropical or subtropical. The climate is influenced by monsoon winds, which come from the southeast in summer, and by winds from the west and northwest in winter. Summer temperatures throughout most of the Indus Plains are high, with temperatures exceeding 115° F. not unusual. Due to high temperatures, evaporation is high. Theoretical lake evaporation varies from 57 to 75 inches a year in the northern areas, and from 72 to 87 inches a year in the southern areas. In the northern part of the Basin, average rainfall is between 18 to 22 inches per year, but decreases to less than 4 or 5 inches in the lower part. Most of the rainfall occurs from April 1 through October 15. For the most part, the annual rainfall is accompanied by high year-to-year variability. Irrigation is absolutely necessary for successful crop production in over four-fifths of the Indus Plains.

Several grave problems affect the irrigated agriculture of the

Indus Plains, the principal of which are recurring water shortages resulting from inadequate canal systems, capacities, and water supplies, and rapidly spreading waterlogging and soil salinity in the irrigated areas. As a result, large areas of productive irrigated land have been lost completely to cultivation, or have had production seriously reduced.

General Economic and Institutional Background According to the 1961 population census, there were nearly 43 million people in West Pakistan and population is increasing 2.7 percent per year. The population density averages 38 persons per square mile and there is less than one acre of cultivated land (actually planted) per capita. The great majority of these people are malnourished and desperately poor. Their average income is less than \$0.20 per day; their average life expectancy is less than forty years. Only one out of ten can read effectively or write more than his own name; only one out of a thousand has more than a high school education. They are debilitated by dietary and water-borne diseases and by skin infections. Their meager diet is inadequate, both in energy content and in essential proteins. Their watchword is, "Our sons will have it better".

Agriculture dominates the economy of West Pakistan. Activities directly related to producing and processing agricultural products for domestic consumption provide a livelihood for about 85 percent of the population, employment for 67 percent of the labor force and contribute about 60 percent of the national income. Furthermore, much of the manufacturing consists of processing of agricultural products for domestic consumption. This includes spinning and weaving, tanning of hides

and skins, manufacturing of textiles and leather goods, refining of sugar, processing of oil seeds and grain products and canning fruits.

Pakistan presents the disheartening picture of an agricultural nation that cannot feed itself. Not only are crop yields among the lowest in the world, but they have not increased significantly during the past ten years. Total production has increased an average of 2 percent per year, mostly from new land brought under production, but the population is increasing by about 2.7 percent per year. Imports of agricultural products amount to an equivalent of about 25 percent of the total average diet, consisting of less than 2,000 calories per capita. The potential for increased agricultural production and economic development in West Pakistan are tremendous but numerous obstacles and problems make the task almost futile. These are discussed in detail in relation to the obstacles to evaluation and appraisal of water resource developments presented in Chapter V.

Sources of Data

Data from many sources have been used in this study. References on resource evaluation procedures by agencies of the United States Government were relied on heavily for analyzing the differences in current concepts and criteria. The most important of these were the manuals on Project investigation by the Bureau of Reclamation; the Soil Conservation Service Handbook; the manuals on procedures by the Corps of Engineers; the Bureau of the Budget, A-47; the Inter-agency Sub-committee reports on Proposed Practices and Procedures, commonly referred to as the "Green Book", as modified; and the more recent publication, Senate Document 97.

These references were supplemented by numerous articles in the Journals of the American Farm Economic Association and the Western Farm Economic Association, and the Journal of Land Economics.

Field investigations were conducted on the projects in Guinea, Uruguay and West Pakistan during 1962 to 1963 in connection with overall engineering and economic feasibility studies by teams of experts of the Harza Engineering Company of Chicago, Illinois. As a member of these teams, basic data for the economic feasibility studies for these projects, and for supplemental data for this study were collected by the author. The basic data were collected during extended visits to these countries while the analyses were completed in Chicago.

Personal interviews with farmers and agricultural leaders in each country were made through the use of interpreters to obtain first hand information pertaining to the organization and operation of typical farms or operating units. Because of difficulties in obtaining reliable data from farmers, particularly in West Pakistan and Guinea, it was necessary to supplement much of the data by alternative means. For instance, crop yield estimates were obtained from agronomists and soil scientists on the basis of experience and knowledge of the performance of particular crops under similar environmental conditions in other areas. These estimates were then compared with the crop yields obtained by personal interviews and adjusted when necessary on the basis of the experienced judgment of the technicians.

Secondary sources of information on conditions of each economy, local institutional arrangements, and social conditions, import-export data, population, etc., were relied on heavily for much of the data.

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These included local government reports, embassy reports, statements from government officials, and representatives of businesses and government institutions working on agricultural problems in these countries. Personal interviews with officials of USAID, IBRD and other financing institutions in Washington D.C.; and their representatives in these countries provided data pertaining to methods of evaluation and procedures, terms of financing and organization of the institutions.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Literature on resource evaluation in the United States is considerable. Studies on various aspects related to economic development in less developed countries are far less extensive but there has been considerable interest in this area since World War II. However, most work has been directed more toward problems related to causes of economic growth than to problems of resource evaluation.

Land economists, political and social scientists and other technicians concerned with resource development in the United States have dealt with problems of evaluation since the first public project. Interest in this area of study has increased with the gradual expansion in resource developments, paralleling the growing concern and public interest in our resources as larger and more costly projects influenced more and more people.

This chapter is concerned with a review of some of the past studies that have been conducted by many of these people in their special areas of interest. It is not intended to compile an exhaustive listing of past studies on resource evaluation and related topics, but to summarize a few of the major works in this general area with a view to the relationship of these studies to the general topics of this study, and their possible contribution to this work.

Development of Basic Concepts and Definitions

The report in 1950 by the Presidents' Water Resource Policy Commission represented the most comprehensive statement on resource evaluation up to that time.¹ This Committee was organized at the request of the President to formulate mutually acceptable principles and procedures for determining benefits and costs for water resource projects. The first authoritative statement on project evaluation was the "Green Book" published in 1950.² These works provided the format for many succeeding studies involving modifications and suggested recommendations for improvement in evaluation principles and procedures.

Golze traces the changes in rules for determining financial feasibility of projects by the Bureau of Reclamation, Corps of Engineers and the United States Department of Agriculture.³ He noted that in the beginning of the Federal Reclamation program in 1902, authorization of projects was granted on the basis of being financially feasible if cost of construction could be returned to the United States by the water users in not more than 10 annual installments. Congress gradually changed its feasibility procedure and in 1926 a new provision was added requiring that repayment contracts provide for repayment in not more

¹Presidents' Water Resource Policy Commission, Vol. 1, A Water Policy for the American People. United States Government Printing Office, Washington, December, 1950.

²Proposed Practices for Economic Analysis of River Basin Projects, Report to the Federal Inter-agency River Basin Committee, Washington, May, 1950.

³Alfred R. Golze, Reclamation in the United States, New York: McGraw-Hill Book Company, Inc., 1952, pp. 124-126.

than 40 years. In recent years, some repayment contracts of 60 years have been authorized by Congress.

Recognition of multiple-use features of projects was largely incidental. Congress provided authorization for public power development by the Bureau of Reclamation in 1906, but the first truly multi-purpose project, specifically authorized and designed as such, to be built in the United States was the Hoover Dam. Enacted in 1928, the legislation recognized flood control, navigation, irrigation and hydroelectric power generation as purposes of this project.⁴ Again, in 1939, Congress recognized the difficulty of financing large and expensive multi-purpose projects and modified the rules of feasibility by recognizing benefits that were national in character, such as flood control and navigation, to be non-reimbursable.⁵

In 1944, Cooke recognized that multiple-use of resources added emphasis for the imperative need of unified resource development. He states, "from a social standpoint the river itself becomes a vastly important, multiple-purpose agency which must be nurtured in manifold and unaccustomed to ways while the dam becomes simply an important servitor of the river. In fact, it may be that our present concentration on the dam and the beneficent power it creates has blurred the picture and kept us from realizing all that is involved in the total river use as affecting regional development".⁶

⁴U.S. Department of Interior, Bureau of Reclamation, Federal Reclamation Laws Annotated, Washington, U.S. Government Printing Office, 1947, p. 340.

⁵Golze, op. cit., p. 125.

⁶Morris L. Cooke, "Multiple Purpose Rivers", Journal of the Franklin Institute, CCXXXVII, No. 4, April, 1944, pp. 251-264.

The Presidents' Water Resource Policy Committee recognized the multi-purpose aspects when they stated "the selection of projects and combinations of functions depends on an evaluation which views the program as a whole in all its complexities. ... Project evaluation, if it is to give useful answers, must consider all the various facets of the basin development program. These include the technical, the financial, the economic and the public aspects. In a similar manner, program evaluation must consider all features related to national objectives".⁷

Studies by Huffman noted that "as these multi-purpose potentialities become evident to more and more people, there has been increased emphasis on the study and evaluation of all possible uses in planning for resource development".⁸ He added that "until recently, (1953), public irrigation development and resource development generally, has been formulated, evaluated and authorized on the basis of projects. With the advent of the river basin system of resource development, a broader basis of evaluation and authorization came to the fore. He stated further that "programs of development for entire river basins replaced projects as the unit of planning and operation; while projects are constituent parts of such programs. The problems of evaluation becomes much broader than is the case of project by project consideration because the former is concerned with economic evaluation and including public values". He makes further distinction between projects and programs when he states "the

⁷Presidents' Water Resource Policy Committee, Report of op. cit., Vol. I, p. 58.

⁸Roy E. Huffman, Irrigation Development and Public Policy, The Ronald Press Company, New York, 1953, p. 150.

budgeting procedure for determining the value of irrigation water is typical of the method by which the benefits of a single-purpose resource development may be assessed as they apply to direct beneficiaries. As public resource development became more and more concerned with high-cost projects, it appears imperative that all benefits and detriments be included in the analysis".⁹

Much has been written regarding the lack of coordination and the conflicts among government agencies, and private vs public interests in water and related land resource developments. Some writers have indicated an extreme amount of competition among agencies.¹⁰ The shift from single-purpose resource development to comprehensive multi-purpose stream planning has done much to expand these conflicts. Huffman distinguishes between four concepts of conflicts; the public vs the private, the public vs the state, the public vs the public, and the long-run vs the short-run. He takes the stand that economic factors may make it impossible for anyone except the state to take a sufficiently long-run viewpoint, and that exploitive development and use of resources may be such that only the state is in a position to represent a viewpoint consistent with the long-run public interest.¹¹

Many writers have pointed out the great variation in the terminology used to distinguish between the benefits from resource development which

⁹Ibid, p. 190.

¹⁰Leslie A. Miller, "The Battle That Squanders Millions," Saturday Evening Post, May 14, 1949.

¹¹Huffman, op. cit., pp. 176-185.

can be measured in monetary terms and those benefits to which dollars cannot be assigned. The Presidents' Water Resource Policy Commission used "intangibles" as if it were synonymous with public or social values.¹² This definition is questioned by several writers in view of the fact that intangible benefits are not limited to the general public. Private beneficiaries may also profit from resource values which cannot be assigned a monetary value.

Kelso added refinement to the terms of direct and indirect benefits by relating direct benefits to microeconomic analysis — gains and losses to individual firms — and indirect value to macroeconomic analysis — gains and losses to the economy as a whole. Factors measurable in monetary terms are referred to as tangible.¹³

Wantrup added still further refinement by classifying the benefits as having either market value or extra-market value, the latter referring to those benefits currently outside the existing market structure.¹⁴ He noted that recreational benefits are most prominent among the extra-market values for which monetary measures are being sought. The approach commonly used is to calculate the amount of money the public spends in pursuit of a particular type of recreation which suggests that the tangible

¹²Presidents Water Resource Policy Commission, Report of op. cit., Vol. I, p. 87.

¹³M.M. Kelso, "Economic Criteria for Conservation and Development of Public Lands", Proceedings of the Western Farm Economic Association, Davis, California, June 23-25, 1948, pp. 85-92.

¹⁴S.V. Ciriacy-Wantrup, Resource Conservation; Economics and Policies, University of California Press, Berkeley, 1952, pp. 238-248.

cost of a sport is indicative of its intangible value.

The many different definitions and practices being used by the various federal agencies caused the Federal Inter-Agency River Basin Committee to appoint a Subcommittee on Benefits and Costs in 1946 to formulate mutually acceptable principles and procedures for determining benefits and costs for water resource projects.¹⁵ The work by this Committee is the most comprehensive treatment of the principles involved in appraising the economic feasibility of resource developments and the measurement of benefits and costs both in terms of principles and in relation to specific types of projects. The Committee was given the responsibility to work out a uniform system of economic analysis which would eliminate the differences in procedures used by the various agencies. This work resulted from the general recognition by many people working in resource valuation of the necessity of a common basis of project analysis for evaluation in terms of river basin programs and national resource policy.

Economics of Project Evaluation

There are many writings available on various aspects of the economics of resource evaluation. The primary concern of most workers in this area, though interrelated, may be grouped into these general categories: (1) Studies related to the principles and assumptions of benefit-cost analysis; (2) Definitions and standards for understanding and utilizing the benefit-cost principles and criteria; (3) Practices in applying these

¹⁵Federal Inter-Agency River Basin Committee, Proposed Practices for Economic Analysis of River Basin Projects, Washington, May, 1950.

principles, criteria concepts and definitions to various problem situations and project purposes.

Numerous writers have contributed to this field of study, but the following works are recognized as being perhaps the most comprehensive and significant: S. V. Ciriacy - Wantrup, Resource Conservation, Economics and Policies (1952); Roy H. Huffman, Irrigation Development and Public Water Policy (1953); V. Webster Johnson and Raleigh Earlowe, Land Problems and Policies (1956); and Otto Eckstein, Water Resource Development, Cambridge, Harvard University Press, 1958.

There is wide agreement among these and other writers that the conditions necessary for optimum use of resources and the purpose of economic analysis include; (1) meeting an existing or potential demand, (2) being designed to maximize net benefits, (3) determining the least costly of alternative means; and (4) development of projects in order of their relative desirability. The central principle of optimum development expressed by this group is summarized by this statement by Johnson and Earlowe: "There is no single method for land development and conservation, and assuming that some type of project is socially justifiable, the analysis of costs and benefits is particularly significant in project formulation and design. The aim is to develop a program that will make for the most effective use of the resources, and do so in a manner that will maximize the excess of benefits over costs. Thus, one very significant purpose of an economic evaluation is to determine the combination of resources and the degree of development which will result in maximum net benefits. In doing this, it is necessary to consider alternative uses for funds and to choose between types of projects and

their sizes for different purposes".¹⁶

There is little disagreement among writers on the definitions of direct benefits and costs as presented by the Subcommittee on Benefits and Costs of the Federal Inter-Agency River Basin Committee in 1950 "direct costs are the value of the goods and services needed for the establishment, maintenance, and operation of the project and to make the immediate products of the project available for use or sale (associated costs) ... direct benefits are the value of the immediate products and services for which the direct costs are incurred".¹⁷

The principal research work on evaluation has involved the complex problems of secondary benefits and costs of water-use projects. Significant examples of these works are that of M. M. Kelso,¹⁸ S. V. Ciriacy-Wantrup,¹⁹ Otto Eckstein.²⁰ Numerous other scientists have made valuable contributions to the understanding of this complex problem. Kelso clarified the issue that returns from investment of public funds are matters of "real" output rather than "money" output when he wrote that "increased

¹⁶V. Webster Johnson and Raleigh Barlowe, Land Problems and Policies, New York: McGraw-Hill Book Company, Inc. 1954, p. 139.

¹⁷Op. cit., p. 7.

¹⁸M.M. Kelso, "Evaluation of Secondary Benefits of Water-Use Projects," Report No. 1, Committee on the Economics of Water Resource Development, 1953, pp. 49-62.

¹⁹S.V. Ciriacy-Wantrup, "The Role of Benefit-Cost Analysis in Public Resource Investment", Report No. 3, Committee on the Economics of Water Resource Development, 1953, pp. 18-28.

²⁰Otto Eckstein, Water Resource Development, Harvard University Press, Cambridge, Chapter VII, 1958.

national real income, however it may be caused, may arise as a result of a project from any one of 3, and only 3, conditions:²¹

(1) Employed resources may be shifted from less to more productive uses. Productiveness may be increased in a number of ways such as giving resources a better and more plentiful supply of complimentary resources to work with; or resources may be used to stimulate more efficient use of other resources; or production may be shifted to improved qualities and types of goods, the test of the latter being that people will pay more for them.

(2) Employed resources may be employed closer to desirable capacity. Under this condition production units may be operated at a more efficient scale or interrelated processes may be better coordinated or operation of the units may be made steadier and part time use of them be reduced.

(3) Otherwise unemployed resources may be employed as a result of the developments occasioned by the projects.

Kelso also clarified the issues of benefits "stemming from" and "induced by" projects. Whereas the Sub-Committee on Benefits and Costs and others apparently thought of these as being additional effects of the project, Kelso reasoned that this results in double counting of the benefits, i.e. benefits "stemming from" the project are a form of "supply effects", and that benefits "induced by" the project are a form of "demand effects". He pointed out that it is entirely appropriate to value some of the benefits on the one side of the circle and some on the other, so long as the same benefits are not measured on both sides of the circle.

²¹Kelso, op. cit., p. 52.

Theoretical and empirical work of most writers on the subject of secondary benefits leads the majority to the predominate questions; (a) whether such benefits do in fact exist in a significant amount except in periods of depression (idle resources), and (b) whether they can be measured with any degree of accuracy if, in fact, they do exist. Wantrup stated "when I now try to draw conclusions from this analysis of secondary benefits and costs, I am forced to suggest that all classes of secondary net benefits be dropped from consideration if the problem area is project selection and when one is dealing with the national account".²² Wantrup recognized that in spite of weaknesses in the benefit-cost analysis a major advantage for its use in resource evaluation was "that of stimulus to scientific understanding".

Huffman pointed out that the benefit-cost analysis is similar to the marginal analysis of equating marginal costs and marginal returns, and that it is little different from determination of financial feasibility. He adds that "whenever extra-market gains and losses are considered, it becomes obvious that projects and programs may be justified at some other level than the marginal point in benefit-cost analysis. Obviously, he says, "if extra market values are judged to be of sufficient importance, public expenditures for water resource development can be carried to the point where the over-all benefit-cost ratio for a project is 1 to 1, or it can be carried beyond that point inasmuch as the benefit-cost ratio includes only market values".²³

²²Wantrup, op. cit., p. 27.

²³Huffman, op. cit., p. 199.

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Regarding prices to use in the benefit-cost analysis, most writers agree with the Subcommittee that "all things considered, the most satisfactory approach would result from using prices estimated as they are expected to be at the time when costs are incurred and benefits received".²⁴

Regan and Greenshields took a somewhat different point of view as they wrote "forecasts of the dollar prices actually expected to prevail at the time of benefit and cost occurrence are not necessarily essential. It is more important that the projections reflect the relative worth of goods and services under the resource employment conditions expected during the period of installation and operation of the project. With a high average level of resource employment expected to prevail throughout the life of a project, primary emphasis would be on the "real" values of the goods and services as measured by their purchasing power. Under such conditions, proper evaluation of projects requires comparisons of the purchasing power of the goods and services invested with that of the goods and services produced, each measured at time of occurrence.

Emphasis on real values eliminates secular trends in the general price level as a factor in evaluation. The expectation of inflationary price trends should have little or no significance in determining justification from a public viewpoint. With stable levels of resource employment, the expectation of deflationary price trends would also be eliminated from consideration in analyzing economic justification".²⁵

²⁴ Op. Cit., p. 19.

²⁵ M. M. Regan and E. L. Greenshields, "Benefit-Cost Analysis of Resource Development Programs", Journal of Farm Economics, XXXIII, No. 4, Part II (November, 1951), pp. 866-78.

It is not clear in the statement by Regan and Greenshields, or by other writers that have suggested a similar point of view, that projecting real values is any easier than estimating future price levels. The elimination of the effects of inflation and deflation from the evaluation process is recognized by all economist, however, as being highly desirable.

Dr. Foltz argues for the necessity of public investment during the downward phase of a business cycle. He states, "investments in developmental projects such as water resource programs are of the nature of autonomous investments with powerful induced investment potentials. Investments of a developmental variety such as water resource projects will have a greater potential for induced investment than other types. The most favorable model would be one in which the initial investment is undertaken during a period of widespread unemployment and low utilization of resources. Finally, to make the model still more favorable, the full impact of production of the area occurs at a time when there is severe scarcity of agricultural commodities, so that the effect is to keep prices from becoming inflationary. Under these most favorable assumptions, the benefits of irrigation would be maximized".²⁶

Wantrup took exception to this thesis when he wrote "historically and theoretically the evidence does not support that the induced investment argument offers no convincing reason that an autonomous public investment in water resource development is economically sound if its own benefit-cost ratio is smaller than unity or smaller than that of some

²⁶W.E. Foltz, "Water Resources and Economic Development of the West", Report No. 0, Committee on the Economics of Water Resource Development, December, 1951, pp. 25-56.

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alternative public investment in other sectors of the economy.²⁷ He concluded that theory of market forms is more useful than business cycle theory, especially that of the Keynesian variety.

Most scholars of economic theory argue that it should not be assumed that public investment is never justified in a full employment situation and always justified in a situation of underemployment of resources. The extent of the inflationary effects of public investment is related to the manner in which the public secures the funds it uses. If autonomous public investment is financed through taxation or borrowing from consumers, the inflationary effects will be greatly reduced. If the government borrows the money from banks rather than consumers of goods and services, the inflationary effect may be large.

One of the latest works on economics of project evaluation is by Eckstein.²⁸ He sketches the theoretical framework of benefit-cost analysis and the selection of the appropriate criterion; the theory of the competitive economy and its implications for evaluation of public projects. Eckstein considers the competitive model adequate as the primary base for theoretical framework, subject to possible modifications under such conditions as increasing returns, immobility of labor, unemployment, income distribution impacts and imperfections in the capital market affecting the allocation of resources over time.

²⁷Op. Cit., pp. 61-66.

²⁸Otto Eckstein, Water Resource Development: The Economics of Project Evaluation, Cambridge: Harvard University Press, 1958. This work has a complementary relationship with the authors joint work with John Kristilla, Multiple-Purposes River Development.

Eckstein is in agreement with Barlowe and others in use of benefit-cost analysis for measuring relative rather than absolute value. He is of the opinion that alternative costs are not a substitute for market values of benefits unless they are certain to be undertaken; that the total Federal cost is usually the most appropriate form of budget restraint and the benefit-cost ratio the preferable criterion. He argues that projects should be formulated so as to maximize benefits within given budget restraints, with the benefit from the marginal dollar of expenditure the same for all projects and purposes.

The most controversial issue in Dr. Ecksteins' treatise is his treatment of interest. He favors treating risk through a premium allowance in the interest rate and feels that the depreciation rate should be geared to the true rate of capital obsolescence. He proposed a compromise in handling interest in which a relatively low interest rate would be used in evaluation and design, but only projects constructed having sufficiently high benefit-cost ratios to assure an average rate of return as high as in the sources from which resources are diverted.

Since the passage of the Flood Control Act of 1936, with the proviso that a project is justified "... if the benefits to whomsoever they may accrue are in excess of the estimated costs ..." there have been numerous attempts to put a price tag on intangibles and secondary benefits in project evaluation. This has stimulated studies to develop methods of identifying and measuring these benefits. However, there is wide divergences of opinion between economic purists who want to judge projects entirely in economic terms and others who would assign important social political and other non-economic value considerations to proposed

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developments.

An excellent example of an attempt to measure project intangibles in monetary terms is Clawsons' work on the value of outdoor recreation.²⁹ Whereas, Hammond is critical of benefit-cost analysis as it applies to all water resource projects and as being second best for water pollution control projects. He concludes that "water-pollution control projects, as a class, do not lend themselves to benefit-cost analysis".³⁰ His arguments presented for neglecting economic efficiency considerations in justifying pollution-control projects are: (1) The costs are not onerous compared with other items of municipal expenditure; and, (2) Water may be underpriced and, therefore, it is rational to welcome any measure that increases its price. He concludes that cost-sharing arrangements between cities would lead to a more economical solution to the pollution-control problem.

Perhaps the "Chicago" group is most notably for concentrating efficiency criteria and market theory analysis to water resource evaluation. Hirshleifer, et. al., find it difficult to take intangible and secondary benefits seriously. In their view, intangible benefits are usually "invented" ... "they seldom have any important weight and usually are dragged in to serve purpose of securing the real magnitudes of benefits

²⁹Marion Clawson, "Methods of Measuring the Demand for and Value of Outdoor Recreation", Washington, D.C., Resources for the Future, Inc., RFR Reprint Ser. 10, 1959.

³⁰R.J. Hammond, Benefit-Cost Analysis and Water Pollution Control, Food Research Institute, Sanford University, Sanford, 1960.

and costs ...".³¹

Johnson and Barlowe, after pointing out the serious effect of deficiencies in the present framework of economic investigations summarizes with this statement ... "Deficiencies in the program of economic investigations in connection with Federal resource projects cannot be overcome merely by developing uniform interagency standards at benefit-cost analysis at the individual project level. Coordination and improvement of individual project investigations would indeed be helpful, particularly in appraising individual project and alternative choices of operation in a particular situation. But needed also is an expanded investigative framework under which individual project investigations will be complemented by coordinated investigations of the public-welfare aspects of these projects from regional and national perspectives".³²

Huffman stated "evaluation procedures must include a combination of economic analysis and value judgment. The individuals who contend that the evaluation of public resource development can be handled entirely within a precise economic formula are as open to criticism as those who would ignore economic analysis and depend on judgment alone".³³ Bunce stated "The economics of today must deal with individual economics, social economics and the basic causes of divergence between individual and social net returns if it is to be useful in the formulation of social policies. Similarly, social planning should make use of relationships revealed

³¹Hirshleifer, J., J.C. De Haven, and J.W. Milliman, Water Supply, University of Chicago Press, Chicago, 1960.

³²Johnson and Barlowe, op. cit., pp. 144-145.

³³Huffman, op. cit., p. 215.

through theoretical analyses in order to develop the most reasonable policies".³⁴

Kuznets has this to say regarding adequacy of market economics to deal with processes of economic growth: "The field of study (economic growth) has been plagued by looseness in definitions, unusual scarcity of data, and measures of strangely held opinions. If we are to deal adequately with processes of economic growth, processes of long-term change in which the very technological, demographic and social frameworks are also changing --- and in ways that decidedly affect the operation of economic forces proper --- it is inevitable that we (economists) venture into fields beyond those recognized in recent decades as the province of proper economics. For the study of the economic growth of nations, it is imperative that we become more familiar with findings in those related social disciplines that can help us understand population growth patterns, the nature and forces in technological change, the factors that determine the characteristics and trends in political institutions and, generally, patterns of behavior of human beings --- partly as a biological species, partly as social animals. Effective work in this field necessarily calls for a shift from market economics to political and social economy".³⁵

Agricultural Development in Less Developed Countries

The increased role of the United States in international affairs

³⁴Arthur C. Bunce, Economics of Soil Conservation, The Iowa State Press, Ames, Iowa, 1942, pp. 154-155.

³⁵Simon Kuznets, "Economic Growth and Income Inequality", The American Economic Review, March, 1955, p. 25.

in recent years has resulted in new stimulus to both theoretical and empirical studies on economic growth and development. Many American colleges and universities have committed themselves, and have often provided the leadership in marshalling human and technical resources to bear on socio-economic problems in less developed nations. Many of these studies have resulted as side effects from the primary assignments of personnel in these countries in their special fields of interest. Several writers have had a primary aim of exploring the possible role of water resource development and related projects as major vehicles for developing agriculture and the rural communities. Only those studies of particular significance to this study are listed here.

One of the most notable contributions to this field is Nurkses' work in 1953. He outlined many of the problems and means of capital formations in under developed countries. He contended that the amount of capital available for investment may be augmented by utilizing the saving potential concealed in rural underemployment.³⁶

Mellor concluded that the crucial roles of agriculture in early stages of economic development are: "(1) providing agricultural production to meet the growth in demand generated by a growing population and rising per capita income"; (2) providing the labor force for expansion of the non-farm sector of the economy; and, (3) providing capital for economic transformation".³⁷ He argued also that any official encouragement

³⁶Ragnor Nurkse, Problems of Capital Formation in Underdeveloped Countries, Oxford University Press, 1953.

³⁷John W. Mellor, "The Process of Agricultural Development in Low-Income Countries", Journal of Farm Economics, August, 1962, pp. 700-716.

to development of agriculture in poor countries requires (1) identifying the scarce and the plentiful factors of production, and (2) setting the stage to use the former sparingly while fully exploiting the latter. Bottomley questions Mellors' thesis that agricultural labor in underdeveloped countries is plentiful nor is land scarce as far as more extensive cultivation with existing techniques is concerned. He states that "it is the arrangements under which the land is held that creates the illusion of scarcity".³⁸

Work in Pakistan and India by Bredo led him to conclude that development of agriculture is essential at an early stage in order to feed the population and finance the development of the country. Rapid economic progress requires interdependence carefully planned of industry and agriculture. He states "if economic development programs are to be supported, there must be an increase in foreign exchange earnings, as well as an increase in national income to provide a broader tax base".³⁹

From studies by Neumark in Africa, he concluded that one of the great needs is a link between the so-called subsistence sector and the rest of the economy. He believes that the missing link is transport and marketing facilities, and that capital spent on technical improvement of production may be largely wasted unless transportation and marketing facilities are made available simultaneously.⁴⁰ Walker believes that the "break-through"

³⁸Anthony Bottomley, "Comments on The Progress of Agricultural Development in Low-Income Countries", Journal Farm Economics, Vol. 45, No. 2, May, 1963, pp. 446-448.

³⁹William Bredo, "Rural Industrialization for Agricultural Development", Journal Farm Economics, December, 1959, Vol. III, No. 5, pp. 1332-1344.

⁴⁰S.D. Neumark, "Some Economic Development Problems of African Agriculture", Journal Farm Economics, February, 1959, pp. 43-50.

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requires concentration upon exports, and if such a policy is successful increased inter-regional trade and specialization will follow.⁴¹

Pasto criticizes studies made in less developed countries for being oriented to macro-analysis when actually "it is shown that lucrative opportunities for raising productivity and employing labor more fruitfully exist right on the farm". He also noted that lack of planning for efficient use of water on farms has been especially evident in irrigation projects. Most often overlooked is provision for showing farmers how to reorganize their farms from dryland systems to one under irrigation.⁴²

Nervik and Hughjoo argue against contemporaries who contend that mechanization of farms upset the prevailing social system and forces many farmers off the land. They contend rather that -- "farmers leave the farm because of low farm incomes and rising living costs, and therefore, more farmers have been displaced by oxen plows than tractors".⁴³

Brewster maintains that the dominant striving of people of all cultures is status aspirations. He states, "this status aspiration function can become a powerful generator of economic growth if it is guided by the belief that proficiency in economic as well as non-economic employment is the appropriate way of earning an even higher valuation of himself in

⁴¹David Walker, "A Note on the Economic Development of East African Agriculture", Journal Farm Economics, February, 1959, pp. 871-878.

⁴²Jerome K. Pasto, "The Role of Farm Management in Underdeveloped Countries", Journal Farm Economics, Vol. ILIII, August, 1961, pp. 606-625.

⁴³Ottor Nervik and E. Hughjoo, "Mechanization in Underdeveloped Countries", Journal Farm Economics, Vol. ILIII, August, 1961 pp. 663-666.

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his own eyes and in the eyes of others".⁴⁴

In conclusion, emphasis might well be placed on the point that water resource development by itself provides no guarantee of economic development. This involves the interplay of numerous factors but probably no factor can play a more strategic role in less developed countries than development of natural resources. The intangible and secondary effects from project developments in these countries are usually much greater than from a similar project in a highly developed country. It often acts as the catalyst that sets in motion the whole stream of economic, social economic development.

This has not been intended as an exhaustive review of all possible fields of interest in resource development and causes of economic growth. Rather, this selection of articles presented here is intended to show the general areas of interest in these fields of study and some problems that this has brought out. At best, it may be taken as a cross-section of interest displayed in the whole problem area that seems to follow evaluation and development of resources. References to other outstanding contributions to specific topics under discussion are made throughout the text of this study.

⁴⁴John M. Brewster, "Beliefs, Values, and Economic Development", Journal Farm Economics, Vol. ILIII, November, 1961, pp. 779-812.

CHAPTER III

APPRAISAL OF CRITERIA AND EVALUATION PROCEDURES

The Need For Project Evaluation

The development of water resources is a major area of government policy in most every country. The investment decisions made in this area are necessarily collective ones; the very nature of the resources involved largely preclude the private sector from making adequate investments in water resources. However, the principles which determine individual action are equally applicable to public decisions.

Some water resource project activities will not be voluntarily undertaken in a predominately free-enterprise society even though private investment funds may be plentiful. These activities are those which do not produce an easily marketable product, (i.e. flood control) or where some common resource is involved that cannot be uniquely claimed by any of its several users. Net gains are available to an economy in transferring resources into these types of activities, and only a government has the incentive to do it; only a government can operate them without direct receipts from sale of output or be able to organize the resources in the face of adverse institutional arrangements.

Application of carefully chosen criteria and evaluation techniques is necessary to avoid favorable decisions on non-economic investments; namely, those investments which earn a collective return less than they would in alternative investments. To fail to undertake a justified

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project -- an investment which contributes as much or more to national income as the resources involved would in the absence of the project -- is, of course, no lesser evil than decreasing income and welfare by undesirable projects.

In addition to choosing between the "good" and "bad" projects, the decision-makers must strive to obtain the benefits at the least cost. This will maximize the return to the government investment in the sense that all benefits which can be economically obtained are available with the smallest possible reduction in alternative activities. Application of this basic concept in the selection of the type and the scale of projects is especially important in less developed countries as economic consequences to overall development of the economy is more serious when investment funds are extremely limited relative to the alternative investment opportunities.

In addition to providing decision-makers with a means to judge the feasibility of proposed investments, decisions on water resource developments must reflect the philosophies, attitudes and values of their society. These are usually embedded in the goals of government policy, and the effects of water resource development on the realization of these goals is not an inconsequential consideration. The actual decision-making must be responsive to both the positive economic facts and the realization of these goals.

Evaluation of water resource projects is needed to meet basic loan requirements of the financing agencies. As a primary criterion, all agencies require that projects be economically and technically sound. This requirement forces the borrowing country to have projects evaluated in

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sufficient detail to meet the financial requirements of the loaning agency.¹ For instance, the Foreign Assistance Act of 1961 specified that in exercising the authority granted to the President of the United States to make loans and grants to promote the development of less developed countries a major criteria would be "the economic and technical soundness of the activity financed". The soundness of a project is to be judged by the following general criteria:

(1) Technical Soundness A project is considered technically feasible if:

(a) All pertinent aspects of the project have been taken into account in the analysis;

(b) The planned construction or procurement conform to accepted engineering standards and practice, suitably modified in light of the actual stage of development of the applicant country, and its projected rate of development;

(c) The estimated cost of the project is as low as any other reasonably available alternate which would produce the intended results.

(2) Economic Soundness A project will be considered economically sound if the resulting economic benefits over a stated period will equal or exceed the total costs of construction, maintenance and operation over the same period.

With respect to water or related resource projects, the 1961 USAID Appropriation Act requires that the computation of benefits and costs for

¹Basic conditions and requirements for loans by each of the major financing agencies are summarized in Appendix Table I.

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new flood control, reclamation or other water or related land resource projects or programs be made by the methods prescribed in Circular A-47 of the United States Bureau of the Budget, and that the standards and criteria of that Circular be met.² This includes all projects involving water supply, regulation or improvement of waterways, hydro-electric power, and development and improvement of ports and harbors.

The International Bank for Reconstruction and Development (IBRD) and its affiliate, the International Development Association, also makes loans only for projects which are technically and economically sound. That is, for projects which, in their judgment, can be effectively executed and operated and will result in benefits which will justify the investment and strengthen the economy of the particular country. The evaluation procedures and criteria specified by the Bureau of the Budget, A-47, and the more recent document, of course, meet requirements and standards expected by the IBRD although there is no official directive specifying that these specific references be used.

Status of Development of Evaluation
Procedures in Less Developed Countries

Procedures developed for evaluation of water resource projects in West Pakistan, Guinea or Uruguay are in a state of infancy compared with

²Circular No. A-47, Bureau of the Budget, Executive Office of the President, December 31, 1952 has been superseded by Senate Document No. 97, Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans For Use and Development of Water and Related Land Resources, prepared under the direction of the Presidents' Water Resource Council, 1962.

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those in this country. This situation is apparently true for many other countries of the world.³ Interviews conducted in these countries by the author with officials of appropriate government agencies indicated little knowledge of procedures for benefit-cost analysis, cost allocations or other basic resource evaluation concepts. Of the personnel interviewed who were working on resource development, few were found that had any formal training in agricultural economics. It was apparent that trained personnel, regardless of their field, are employed mostly in administrative positions of their governments.

All known reclamation and irrigation projects planned in these countries in recent years have had some kind of economic analysis. For irrigation projects, this usually consisted of very rough estimates of anticipated increases in gross crop value. Estimates of farm costs are made occasionally but in no case was there reliable data on farm production costs. Financial analysis involving repayment of project costs have been entirely neglected except for some very vague discussion and generalities. In the majority of cases, the water users were not expected to repay project costs except for operation and maintenance. Decisions to construct some projects were justified on the basis of need for additional food, or because of "political promises" to do something for a particular area.

Projects in these countries financed by loans and grants from foreign sources require evaluation as a condition for obtaining the foreign

³S.V. Ciriacy-Wantrup, "The Role of Benefit-Cost Analysis in Public Resource Development", Report No. 3 on Benefit-Cost Analysis by Committee on the Economics of Water Resource Development, December, 1954, p. 18.

exchange component of the investment costs. The services of foreign consultants are usually engaged to conduct the feasibility studies. The evaluation procedures used in the feasibility studies of all projects known to have been financed from foreign sources in West Pakistan, Guinea and Uruguay were patterned after those used by government agencies in the United States. As far as could be determined, similar procedures were used also on the studies that had been completed by non-United States consultants. Because evaluation procedures have reached a higher professional level in the United States than elsewhere, and because this is the major source of funds for financing projects, it can be expected that procedures similar to those used by United States government agencies will be used for evaluating potential projects in less developed countries.

Adequacy of Economic Analysis of Projects
in Less Developed Countries

Officials of the IBRD, USAID and IDB in Washington, D.C., and the FAO in Rome indicated that most feasibility studies submitted in support of project financing have been inadequate. For instance, during a two-year period, 1961-62, the IBRD received feasibility reports on 26 irrigation projects for which loans were requested by governments of various less developed countries. Of these, only 14 were recommended for approval by the Bank. Consideration of loans on seven projects were deferred for further study and five projects were rejected. The feasibility studies on five projects were undertaken by irrigation authorities of the borrowing countries and 21 by consultants under contractual arrangements. There was positive indication that the feasibility studies performed by

consultants were of better quality than those received directly from local irrigation authorities.

One IBRD official stated that there was no case where the Bank was satisfied with the agricultural, financial and administrative aspects of the project studies submitted to them.⁴ This was true also for projects that had actually been approved by the Bank for financing. It was reported that in the majority of cases, the treatment of these aspects was considered seriously inadequate.

Results of interviews with officials of the other financing agencies, including the FAO in Rome, supported the statements of the IBRD officials. The reasons given for inadequate feasibility studies and sub-standard performances in evaluating potential projects in less developed countries were summarized as follows:

(1) Almost invariably, engineers have primary responsibility for the feasibility studies of irrigation and related water resource projects. Too often their attention has been focused on the means of achieving the purpose of the project instead of on the purpose itself. They are so closely concerned with the works of the project that they have concentrated on these to the exclusion of the non-engineering aspects. There is a tendency to overlook the fact that an irrigation project is for irrigation and productive use of the land, rather than the construction of a dam and a distribution and drainage system alone.

(2) There is a general lack of coordination of the evaluation among

⁴P.A. Reid, Chief, Agriculture Division, International Bank for Reconstruction and Development, Washington, D.C.

the investigation team, and frequently engineers, agriculturalists and agricultural economists are not closely associated in the feasibility study. In some instances, the agricultural and economic studies had been carried out independently of the engineering studies. An agriculturist, just as an economist or an engineer, tends to look at a project too much from his own viewpoint. It is necessary for these viewpoints to be coordinated so that the project can be assessed as an entity.

(3) Inadequate agricultural and related data. This deficiency was an unanimous criticism of most feasibility studies. Reliable statistics from which to adequately assess present production of a project area or the production of similar areas already developed under irrigation were lacking. The most serious inadequacies pertained to lack of data regarding soils, agronomy, water duties, markets and economics of farm production.

(4) Inadequate coverage of institutional problems which could seriously prohibit attainment of reasonable standards of agricultural production and operation of the works after the project is constructed.

(5) Inadequate coverage and consideration of different economic systems and the imbalances in existing resource use. There was insufficient consideration of the effect on successful completion and operation of a project due to lack of technical know-how, managerial experience and capital. Too little consideration was given to administrative operation and management of a project after it was constructed, and to agricultural development programs necessary to attain the projected production levels.

Current Evaluation Practices in the United States

Development of Concepts and Practices

The development of prevailing concepts and practices in water resource evaluation in the United States has been an evolutionary process. While benefit-cost analysis antedates the Flood Control Act of 1936, that act laid down the proviso that a project is justified " — if the benefits to whomsoever they may accrue are in excess of the estimated costs —".⁵ It was not until 1950, however, that specified procedures and recommendations were spelled out in a formal statement by the government. This reference is commonly referred to as the "Green Book" and has been revised since 1950.

The Bureau of the Budget Circular, A-47, was issued in December, 1952. This circular reflected the Inter-Agency Committee considerations, and contained some modification of proposed practices of the Green Book. The work of the 1950 subcommittee was modified in 1954 and its name changed to Inter-Agency Committee on Water Resource with a Subcommittee on Evaluation Standards. A considerable part of the work of this Subcommittee was that of reviewing the 1950 report to revise and reissue such changes as necessary to reflect views current to that time. Circular A-47 was revised in November 1954, and again in May 1960, but never issued.

The Presidents' message of February 23, 1961 to Congress on natural

⁵Subcommittee on Benefits and Costs, "Proposed Practices for Economic Analysis of River Basin Projects". A report to the Federal Inter-Agency River Basin Committee, May, 1950, Washington D.C., Revised, May, 1958.

resources stated that he was "instructing the Budget Director, in consultation with the Departments and agencies concerned --" to reevaluate current standards for appraising the feasibility of water resource projects".

In response to this directive, the Budget Bureau proceeded to establish a panel of independent consultants, arrange for interagency participation in the reevaluation of standards, and draft a proposed executive order defining responsibilities with respect to natural resources and public works.⁶ A report was submitted to the Bureau of Budget in June, 1961 and made available to the federal agencies.

On April 21, 1961, a letter signed by 22 Senators was sent to the Secretary of Interior, with copies to other selected resource agencies, citing the inadequacies of Circular A-47, the need for new policies and directives, and new administrative arrangements.

On October 6, 1961, the President sent a memorandum to the Secretaries of Interior, Agriculture, Health, Education and Welfare and Army requesting them to review existing standards for the formulation and evaluation of water resource projects and to recommend any necessary changes. On May 15, 1962, the four Secretaries submitted to the President a statement, "Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources". This statement is commonly referred to presently as Senate Document 97. The President acknowledged the statement, and

⁶The panel consisted of Maynard M. Rufschtmidt, Chairman; John Krutilla; and Julius Margalis. Stephen A. Marglin assisted in the preparation of the report of the panel.

the Director of the Bureau of the Budget immediately rescinded A-47. Though nothing really basic was changed from previous procedures by Document 97, some modifications and clarification of concepts were made. These are discussed in connection with the appraisal of current procedures in the next section.

Differences in Evaluation Practices Among United States Agencies

The objective of the Senate Subcommittee has been to develop a theoretically sound basic framework in order to provide a more systematic and consistent basis for economic analysis of projects. To this extent there has been considerable improvement and, in general, the procedures of analysis are now quite similar among the various water resource development agencies. For example, the annual benefit-cost ratio is now the criterion uniformly accepted by the United States Army Corps of Engineers, Soil Conservation Service, Bureau of Reclamation and the Inter-Agency Committee on Water Resources.

In spite of efforts by the Senate Committee, however, evaluation practices vary significantly between Federal water resource agencies; thus, in some cases the recommended practices are accepted by some agencies and not by others. Basic differences exist in concepts, measurement methods and standards, and in the comparability of benefits and cost estimates. Certain of the difficulties result from legal and administrative provisions applicable to particular programs, some have grown out of difficulties inherent in practical application, but a large portion results from the absence of an adequate framework of concepts and principles. Aside from these causes for differences, a fairly substantial gap often exists between the prescribed practices and those actually applied

by resource agencies in the analysis of particular projects. Major differences in practices among the agencies are noted below:

Period of Analysis The Corps of United States Army Engineers (Corps) and Soil Conservation Service (SCS) agree on a 50-year maximum period of analysis; the Bureau of Reclamation (BR), however, makes its studies both on a 50 and a 100-year basis. The Bureau of the Budget (BB) recommends the estimated economic life or 50-year time horizon as a maximum, while the Inter-Agency Committee admits a period up to 100 years. Senate Document 97 recommends that the period of analysis should be the shorter of either the physical life or the economic life of the structure, facility, or improvement with 100 years normally considered for irrigation projects. Some exceptions to the 50-year maximum apparently exist for some of the agencies. The effect of the differences in the period of analysis is not independent of the treatment of salvage value or the shape of benefit and cost streams over time. Shortening of the period of analysis reduces the attractiveness of the project either by reducing the benefits or by increasing annual capital costs (via the reduced amortization period).

The SCS, which uses a 50-year period of analysis, has in the past offset the detrimental effects (on project justification) of the reduced time horizon by increasing salvage values (remaining salvage productivity value). In this way they have largely nullified the effect of the 50-year maximum for project analysis.

Price Levels Current price levels are used by all agencies for estimating project costs. The Corps use present prices in all benefits and cost projections while the BR utilizes these prices for only the power aspects of projects. On the other hand, long-term price projections are

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employed by the SCS as well as by the BR for other benefits and costs.

The variation in prices assumes more importance the greater the overlap there is in the functions of the separate agencies. Since the benefits of projects undertaken by the various agencies are of different natures the effect of this variation will vary with the importance of a particular function. That is, in some cases, current prices are reasonable predictions for future prices; however, this is perhaps less plausible for irrigation projects than elsewhere. It is not known if the Corps, for example, would use current prices if analyzing a project of strictly agricultural benefits but if so, the Corps would find larger benefits than, say, the SCS.

Senate Document 97 states that prices for project evaluation should reflect the exchange values expected to prevail at the time costs are incurred and benefits accrued. Price relationships expected with a stabilized general price level and under relatively full employment conditions of the economy (projected normal prices) should be used to estimate benefits and deferred costs. In the absence of actual or simulated market prices for products and services, the cost of alternative means that would most likely be utilized to provide the equivalent products or services will be used as benefits. When a projects' output is sufficient to affect prices, a price mid-point between "with" and "without" prices is recommended as a basis for estimating project benefits. This will tend to increase benefit-cost ratios compared to a system in which project benefits are valued at market value.

Investment Costs. For all agencies, investment costs cover all costs subsequent to authorization of a project necessary to establish that

project. Except for the SCS, interest during construction is included. Both the BR and the Corps reduce this cost by the salvage value of the project; the Corps' practice in this regard is much more conservative than that of the BR.

The Inter-Agency Committee on Water Resources specifically recommends that investment costs include any induced adverse effects whether compensated or not. On the other hand, the BB spell out that these costs include everything connected with the program regardless of whether they are incurred by the Federal government or not. This latter definition is somewhat more broad than any currently in use. The differences existing in practice can be traced to treatment of specific items such as interest during construction and allowance for salvage.

Senate Document 97 emphasizes that "both national and local employment conditions are to be reflected in the benefit-cost ratio". For instance, in the case of local unemployment this is done by increasing benefits by the amount of unutilized or under utilized resources. This concept has particular significance in evaluation of projects in less developed countries where labor resources, in particular, are frequently chronically unemployed or under employed. If resources are otherwise unemployed, their opportunity cost is zero, and payments to laborers in constructing a project may simply involve a redistribution of income for the total economy rather than an economic cost. If treated as increased benefits rather than reduced project costs, the benefit-cost ratio is affected in a conservative direction.

It would be more desirable to have the benefit-cost ratio represent the economic costs and returns to the nation or country as recommended by

the Inter-Agency Committee. It appears that the main reason for including costs for unemployed resources as benefits rather than reduced project costs is because the cost figures represents needed appropriations for the project.

Interest Rates for Converting Cost and Variable Benefit Streams The interest rate to be used in plan formulation and evaluation for discounting future benefits and costs to a common time basis is specified by Senate Document 97 to be based on the average rate of interest payable by the Treasury on interest-bearing securities of 15 years or more. However, the rate structures employed by the various agencies are more complex. For converting variable future cost streams to annual costs interest rates now used are as follows:

Corps of Engineers:

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| 1. Federal Costs | 2 7/8 Percent |
| 2. Non-Federal Government Costs | 2½ - 4½ Percent |
| 3. Non-Federal Private Costs | 4 - 6 Percent |
| 4. Land Costs | 5 - 6 Percent |

Soil Conservation Service:

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| Cost Eligible for Assistance
under P.L. 1018 | 2½ Percent |
| Other Costs (Non-Federal, Public
and Private) | A long-term rate not less
than Federal rate. |

Interagency Committee on Water Resources: Projected long-term rates, approximated by average yield of long term government bonds plus risk premium.

Bureau of Reclamation

2 7/8 Percent

Bureau of the Budget

The average rate payable on outstanding treasury obligations at the end of the fiscal year preceeding calculations which upon issue had maturities not more than 12 months longer or shorter than the economic life of the project. (Same discount rate as used for benefits).

The average rate for all costs by the Corps will be greater than that used or recommended by any other agency. Thus, the Corps' rate will tend to reduce the annual equivalent costs relative to other agencies. This different treatment of the various types of costs by the Corps is not understandable because it makes economic sense only if it can be shown that the variability of the several cost estimates is such that the rate differential represents a risk premium. The impact of interest rate differentials as affected by the time shape of the benefit and cost streams is discussed in more detail in Chapter IV, but is briefly summarized here.

The higher interest rate discriminates against those projects with increasing benefit streams over time; the lower rate against those with benefit streams declining over time. Since most benefit streams are assumed to increase to a maximum (capacity) and then stabilize, the practice of the Corps and the SCS will generally result in lower annual equivalent benefits than that of the BR. Whether or not a historic average rate of interest is economically sound or meaningful is discussed later.

Discount rates for amortizing investment for each agency are the interest rates specified above. The implication of this difference in rates is not independent of the time horizon. Annual amortization costs will be higher, the higher the interest rate, the nearer the time horizon, or the lower the salvage value. Since the BR uses the longest time horizon and the lowest interest rates, it will, other things equal, have the lowest amortization costs. The SCS while using a somewhat higher effective interest rate, reduces the amortization cost by inflating salvage values. Finally, the Corps will have the highest amortization costs due to the 50-year time horizon, as well as higher interest rates.

Allowance For Operation and Maintenance Costs These costs are to include all those costs not considered initial investment costs; i.e. all charges necessary for the operation and full utilization of the project once it is installed. There appears to be no variation among the several agencies in the manner in which they say they define costs. The only differences that do exist are with respect to the prices used for actual prediction of these costs. The SCS and the BR use projected future prices. The Inter-Agency Committee and Senate Document 97 suggested that these costs be estimated in terms of long-range projected prices.

Salvage Values of Land and Major Structures Both the Corps and the BR restrict salvage to the present worth of non-project uses of the investment.⁷ The Corps, however, includes only land, while the BR includes the junk value of the major structures or facilities. The SCS makes additional allowances of "remaining salvage productivity value", which apparently reflects expectant (discount) value of net benefits for the remaining (projected) life of the project.⁸ The differences in treatment of salvage values is essentially to change the time horizon. In effect, the SCS's practice is to use a substantially longer time horizon than the Corps or the BR. The Inter-Agency Committee on Water Resources and Senate Document 97 suggest a procedure similar to that of the BR.

Allowance in Lieu of Taxes The SCS makes no allowance in lieu of taxes as it assumes no land is taken from the tax rolls. The implicit assumption here is apparently that the resources invested by the

⁷Present worth of a sum of money in the future will be higher, the lower the compound interest rate and the nearer the time horizon.

⁸Described in the Soil Conservation Service Handbook.

government would yield no tax revenue if put to alternative uses. The BR likewise makes no allowance except in the case of hydropower, where it includes at least part of the taxes foregone on the alternative source of power. The Corps does likewise. Thus, there is no basic difference in philosophy; only private steam power installations foregone are considered sources of tax losses, and since the SCS is not developing power it neglects taxes completely.

The Inter-Agency Committee recommends that adjustments be made representing the difference between government services required with the project and its alternatives, if any. The BB corrects by the change in state and local tax revenues less changes in costs of services. Senate Resolution 148 is the most comprehensive. It considers increased state and local taxes as costs and increased services as benefits; in addition, it recommends tax revenue foregone on the private alternative to be entered as a cost. Further analysis of taxes foregone as a cost is presented in Chapter IV.

Benefits From Increased Agricultural Production The Corps and the SCS both measure these benefits as increases in net farm income. The BR also adds indirect benefits (increases in profits of local business) and public benefits (increases in settlement opportunities). The recommendations of the Inter-Agency Committee on Water Resources as well as the BB are quite consistent with the practices of the Corps and the SCS.

The BR will always find larger benefits from increased agricultural production than will the gross benefits as they represent the return to resources outside agriculture, on presumably mobile resources which have a positive opportunity cost not vastly different than the return

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it earns in the project area. If gross secondary costs were taken into account by the BR, their results would not be very different from the other agencies.

Benefits From Increased Use Of Nonagricultural Property The BR applies a $2 \frac{7}{8}$ percent interest rate to the estimated increase in the market value of land for residential use.⁹ The Corps estimates such benefits by applying the current average rate of return associated with the activity concerned to the increased capital values. Alternatively, they estimate the actual increase in earnings where observable. The SCS uses a rate between 4 and 6 percent to convert increases in capital values to an annual basis. As a result, the BR will, other things equal, have the lowest benefits in this area. There is no basic inconsistency in the measurement objective of these agencies and the only significant factor is the difference in the interest rate used.

Flood Damage Benefits The Corps estimates these benefits as the reduction in land and property damage (restoration costs or reduced value) plus net damage to crops, plus damage to commerce and trade due to its interruption. The SCS procedure is the same, while the BR is known to have adjusted the estimates of the Corps by their assumptions regarding price levels. The Inter-Agency Committee is slightly more comprehensive in their recommendations, while the BR and Senate Document 97 suggests explicit allowance for reduced loss of life.

Navigation Benefits The Corps projects these benefits as savings

⁹Basic on the average rate on outstanding U.S. Government interest bearing marketable securities running for 15 years or more. The recent determination by the Treasury Department in August 1962 has fixed the average at $2 \frac{7}{8}$ percent.

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over the cheapest alternative means of transport plus recreational value produced plus enhancement of land value from use of dredged spoil. The BR uses the estimates made by the Corps after adjusting the price level projections. The Inter-Agency Committee and Senate Document 97 use similar procedures to those currently followed by the Corps. Once again, the only difference results from price level projections.

Water Supply and Pollution Control Benefits All agencies measure these benefits by the cost of the most economical alternative, and where no such alternative exists the benefits are the value of the additional water to the consumer or the reduction in maintenance and operating costs for pollution control. The Inter-Agency Committee recommends much the same. On pollution control, they suggest that benefits include the cost of the most economical alternative, the decrease in cost of water treatment, and increased use of water due to increased quality and quantity. The first and second items are non-additive because it would be double-counting to first include the cost of the most likely alternative; and secondly, to include benefits for decreased downstream water treatment from either the project or the alternative.

Power Benefits The BR accepts either the cost of the most likely alternative or the value of the power to users, whichever is lower, as the benefit of this function. The Corps uses estimates developed by the Federal Power Commission, where benefits are considered to be the costs of the most likely alternative, usually privately-financed steam power. The BB and Inter-Agency Committee recommend practices followed by the BR. Thus, significant differences between agencies will depend on how they determine the costs of the alternative and to the fact that

the BR includes secondary and indirect benefits when determining the value of the power to the consumer.

Fish, Wildlife, and Recreational Benefits None of the agencies have developed sophisticated methods for estimating these benefits. For the most part, rough approximations are made and, hence, vary considerably from one agency to another. The United States Fish and Wildlife Service estimates these benefits for the Corps. The BR estimates fish and wildlife benefits by the expenditures of sportsmen on those activities and also on the gross market value of fish and fur for commercial purposes. The benefits for small boat harbors are based upon the net return of similar craft on a for-hire basis, and other recreational benefits are computed on a value per recreation man-day parameter. The SCS estimates benefits only from commercial fishing and hunting and these are measured in the same way as the benefits from increased utilization of nonagricultural property.

Comparison of Purposes, and Financing
Requirements of Major Financing Agencies

Seven United States and international lending agencies, operating more than a dozen programs, directly or indirectly help finance exports and overseas investments. Their purposes, sources of funds and particular emphasis differ, ranging from the Export-Import Bank whose main function is to stimulate United States exports, to the International Monetary Fund which helps countries deal with foreign exchange and balance of payments problems. But all of them provide loans or other financial facilities which create expanded trade and increased economic activity in less developed countries. There is wide variation in the financing and

administrative requirements of these agencies as shown in the brief summary below:

(1) Export-Import Bank. This bank is the principal United States export financing agency. The promotion of exports, by direct lending or by guaranteeing loans from private capital sources, is its main business.

In the short-term field, EXIM Bank stands behind the Foreign Credit Insurance Association (FCIA), which provides exporters with comprehensive insurance covering commercial and political risks. For medium-term (1-5 years) transactions, which usually involve individual shipments or items of equipment, it offers both direct financing under its Exporter Credit Program and guarantees in conjunction with commercial bank financing. Longer term loans are made for larger projects, usually in conjunction with other lending agencies as part of an economic stabilization or development program. EXIM's credit facilities tend to follow commercial practices as to terms, but are non-recourse. That is, the exporter is not liable in case of default by the importer. Minimum interest rate of 5 3/4 percent is charged and fees vary by market and terms of credit. The period of maturity may vary from 8 to more than 20 years for development loans according to the nature of project.

(2) Agency for International Development (AID). This agency administers the United States foreign economic assistance programs, a substantial part of which is in the form of development loans. Therefore, most AID loans are in countries where, despite the merits of the undertaking, conventional repayment terms are not feasible. For example, where foreign exchange prospects limit debt-servicing capacity.

Loans are made to both governments and private enterprises, and

normally must be related to the development plans or needs of the country concerned. Terms of loans may be more liberal than for any of the other agencies. The period of maturity may be up to 40 years, including a ten-year grace period, and with interest charges of $3/4$ to 1 percent. Based on the nature of the project, however, interest rates up to $5\ 3/4$ percent are charged. A recent directive by USAID specified that the limiting time of 50 years will be applied to all water and related water resource projects.

(3) International Bank for Reconstruction and Development (IBRD).

The "World Bank" lends for economic development, mainly to member governments. "Infrastructive" projects such as electric power, transportation facilities and irrigation predominate. The period of loans averages about 15 years but some are made up to 25 years. The Bank obtains its funds principally through the sale of bonds, and interest rates on its loans reflect those prevailing in the capital markets where the bonds are sold. Currently, the interest rate is $5\ 3/4$ percent, plus 1 percent for commissions and $1/4$ percent for administrative costs.

(4) International Development Association (IDA). This agency was established in 1960 to meet the problem of financing sound, much-needed economic development projects in countries too poor to assume the foreign exchange debt on the conventional terms required by IBRD. The IDA supplements IBRD by lending for very long periods, up to 50 years with 10 years grace period and graduated amortization. Nominal interest rates or "service charges" of $3/4$ to 1 percent are assessed. The IDA cannot lend when private capital is available on reasonable terms.

(5) Inter-American Development Bank (ADB). This, as its name

indicates, is a regional institution. The United States and all Latin American countries except Cuba are members. Loans may be granted for 10 to 20 years in "ordinary" operations and for 10 to 50 years in "special" operations. Depending on the situation, irrigation projects may qualify as a special operation. Currently, interest rates of $5 \frac{3}{4}$ percent are charged for "ordinary operations" and about 4 percent for "special operations", repayable in currency of the borrower. IADB lends to both governments and private enterprise; procurement must normally be in member countries.

IADB also administers, on behalf of the United States, the Social Progress Trust Fund. Its projects are mainly for economic overhead and social development, water supply, sewerage, housing, and land settlement and reform programs. Periods of maturity range from 15 to 30 years with interest rates of $1 \frac{1}{4}$ percent to $2 \frac{3}{4}$ percent, payable in local currency plus a $\frac{3}{4}$ to 1 percent per annum service charge, payable in dollars.

Summary Statement

Considerable differences in procedures and practices to evaluate projects among the various agencies are apparent. It is obvious that the fate of a particular project may be determined by use of techniques acceptable to one agency but not another. The divergencies are due, in the main, to differences in assumptions regarding secondary benefits, interest rates, prices, salvage values, taxes and time periods. The benefit-cost ratios computed by techniques of different agencies for the same project obviously would not be comparable nor would they mean the same thing. The interpretation of these ratios would be even more

contorted if they referred to different projects.

Differences in financial requirements among the various financing agencies are also considerable. A particular project may be financially feasible under terms of one agency but not another. The various financing agencies have distinctive purposes and spheres of activity which tend to supplement and complement each other; however, it is possible for a particular project to qualify for financing from several agencies. Seldom do the project investigators know the exact source of financing prior to conducting the feasibility study. Consequently, various assumptions regarding interest rates, time period, salvage value, etc. must be made which frequently do not conform to the requirements of a particular agency from which the loan is requested. This adds to variations in the results of feasibility studies and is a major source of contention to the project investigators.

It may be concluded that if benefit-cost analysis is to provide meaningful comparative guides for decision making, evaluation practices need to be uniformly applied. Uniform standards across all projects and functions may not always be practical but would facilitate within and between agency reviews as well as public investment comparisons. While each of the agencies may firmly believe their own financing requirements and regulations are sound, there is no apparent reason for large differences for similar type projects. It is left for Chapter IV, the more rigorous and complete discussion of the implications of differences in evaluation practices, alternative recommendations, considerations, and development of a consistent set of criteria and evaluation procedures for economic evaluation of projects in under developed countries.

CHAPTER IV

CONCEPTUAL FRAMEWORK FOR EVALUATION OF WATER RESOURCES PROJECTS

The Criterion

The evaluation of a water resource project is simply an attempt to determine all the beneficial effects to be expected, wherever they may arise, and conversely to consider all the nonbeneficial aspects. To systematically compare the many diverse services and costs connected with a project one must attach monetary values; that is, to attempt to assess in money the value to a nation of services produced and resources used. Hence, we may consider benefits analogous to the gross sales or receipts of a private business and commodities given up by a Nation in lieu of project services. The manner of comparing these two values is the criterion of evaluation, and if the benefits to whomsoever they may accrue are in excess of the estimated costs the project is economically justified.

The presently accepted format for economic analysis of investment in water resource development is the benefit-cost analysis. But the broad phrasing of the sole criterion for project evaluation of "if the benefits to whomsoever they accrue are in the excess of the estimated costs" can lead to several interpretations of the manner in which the overall criterion for project justification can be applied in addition to the conventional benefit-cost ratio.

Assuming an evaluation of intangibles is avoided, it may be more

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desirable to summarize a project in terms of the net tangible benefits anticipated; i.e., total tangible benefits minus total costs, or in terms of the rate of return on invested capital, which is simply the ratio of annual tangible benefits minus annual operating costs to the invested capital. If it is desirable to rank projects such that they will be undertaken in the optimal order, it is clear that the net benefit criterion will prove unsatisfactory since it gives no consideration to costs. The project with the greatest net tangible benefits may have the greatest costs as well, and if the same costs were distributed among several smaller projects where the average net benefits per dollar of costs were higher, the net benefits from the set of smaller projects will be larger and consequently more socially desirable. Ranking by the rate of return criterion ensures that the present value (all future benefits and costs discounted back to current values) of available resources is maximized; that is, no substitution in the order of projects could improve the present value of current resources. The project with the highest rate of return on invested capital would be placed first in the ordering.

On the other hand, the benefit-cost ratio criterion tends to maximize the returns on all costs, not just the capital costs. For a given set of projects, the ranking accorded by the rate of return criterion is, in general, different from benefit-cost; the difference being due to the differences in the amount of capital relative to other inputs. The benefit-cost criterion is biased towards projects where the amount of capital costs to operating costs is higher. This is because the higher the capital costs relative to a given sum of net benefits the lower the rate of return whereas the sum of all costs (capital and operating) is constant in the benefit-cost analysis.

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Maximization of the present value of currently available resources is recognized as the optimal means of allocating these resources among competing users, one use being investment for future income; if present value is maximized, there exists no way of reallocating the resources currently available such that the welfare of the society can be improved in goods and services (for given relative prices and income distribution). However, it has been argued that if capital rationing exists, the benefit-cost ratio criterion becomes the optimum solution.¹ The argument is that the government behaves as if it were subject to capital rationing; that is, it cannot obtain all of the capital at the going rate of interest which it can profitably invest. Given this restraint, one considers not only specific merits of a project but also the extent to which it will jeopardize future projects by consuming funds for operating costs which therefore cannot be invested. The capital rationing case may be strongest if one assumes a fixed budget for water resources development over time,² which will eventually be totally exhausted by operating costs, leaving no funds for investment, regardless of the attractiveness of the

¹Otto Eckstein, Water Resource Development, Harvard University Press, Cambridge, 1958, Chapter III.

²This situation is representative of conditions in most less developed countries where 3 or 5 year development plans call for expenditure of fixed sums of national budgets.

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project.³ Therefore, benefit-cost analysis which favors projects characterized by low operating costs will be superior to the rate of return criterion as the former aims to maximize total benefits on all expenditures on water resources, both present and future. If it is, in fact, necessary to rank the projects (which implies capital rationing) the benefit-cost ratio analysis is desirable.

If water resource investments are not restrained by capital rationing, the choice between the alternative criteria becomes an academic question. Application of either criterion can satisfy the legal requirement that benefits exceed costs, and the only question is the economic feasibility of a project; no ranking is required. Furthermore, any project which has a benefit-cost ratio of unity or greater, evaluated at the relevant interest rate, will have a rate of return equal to or greater than that rate of interest. The proof of this follows:

³There is an implied assumption in this argument that needs emphasis. If benefit-cost ratio analysis is to maximize the return on total government expenditure, it can do so **only** if the relevant interest rate does not change over time. Suppose that the interest rate relevant to the project is five percent; that is the rate used to determine the capital intensity of a project, given the transformation function between capital goods and operating goods and relative prices of those goods. Since the procedure outlined by Eckstein maximizes the rate of return on all expenditures in water resources, it assumes that the interest rate relevant for transformation between future capital goods and future operating goods will also be five percent, in this example. Whereas with the present value method we allocate only current goods, with the current interest rate; the benefit-cost ratio method essentially allocates future goods (between capital and non-capital uses) by the current interest rate. The same assumption is also implicit concerning relative prices of capital and non-capital goods; they will be the same in the future as today. Neither of these assumptions are necessary to the present value analysis.

Let K equal capital costs, B_t and C_t equal benefits and operating costs, respectively, in year t , and r equal the interest rate. The present value of the benefit stream is

$$\sum_{t=0}^T \frac{B_t}{(1+r)^t} ;$$

the present value of costs is

$$K + \sum_{t=0}^T \frac{C_t}{(1+r)^t} ;$$

the benefit-cost ratio is

$$\frac{\sum_{t=0}^T \frac{B_t}{(1+r)^t}}{K + \sum_{t=0}^T \frac{C_t}{(1+r)^t}}, \text{ which is unchanged}$$

if converted to annual equivalents. If the ratio equals unity, then

$$\sum_{t=0}^T \frac{B_t}{(1+r)^t} = K + \sum_{t=0}^T \frac{C_t}{(1+r)^t}$$

If the rate of return is also equal to r , then

$$\sum_{t=0}^T \frac{B_t - C_t}{(1+r)^t} = K$$

By rearranging terms, we see that:

$$\sum_{t=0}^T \frac{B_t - C_t}{(1+r)^t} = \sum_{t=0}^T \frac{B_t}{(1+r)^t} - \sum_{t=0}^T \frac{C_t}{(1+r)^t} = K$$

and

$$\sum_{t=0}^T \frac{B_t}{(1+r)^t} = K + \sum_{t=0}^T \frac{C_t}{(1+r)^t}$$

Hence, the two criteria converge and any project admissible by the requirement that the benefit-cost ratio be unity or greater will also be admissible by the parallel requirement that the rate of return be equal or greater than the interest rate used. Thus, if capital rationing is not a reality, the importance of this criterion is vastly reduced; other

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considerations must dictate the actual method selected.

In the United States, there is fairly clear evidence that Congress has been willing to appropriate funds for projects of a very marginal nature and it is not unlikely that funds are available for projects not economically justified.⁴ This is true also of the agencies which finance projects in less developed countries, and of the governments of the less developed countries in cases where they have provided their own financing.⁵ Several projects in West Pakistan and in Uruguay have been built in advance of economic feasibility studies. The bases for justification in these instances were to promote national unity by "doing something" for isolated areas and for other humanitarian purposes.

If we can expect Congress, international financing and other governments to continue to authorize and appropriate funds to all justified projects, it matters but little whether we use the benefit-cost ratio or the rate of return method, either can be designed for simple interpretation. The straight-forward rate of return method (where the discount rate which equates the present value of net benefits to capital costs,

⁴For instance, data on 13 existing projects by the Corps of Engineers showed benefit-cost ratios varying from 1.07 to 3.17 (Appendix Table 2). Only one benefit-cost ratio was in excess of 3, and five were less than 1.25. Similar data on projects by the Bureau of Reclamation and Soil Conservation Service show numerous cases where funds have been appropriated with benefit-cost ratios of less than 1.1. Considering also that benefits are overestimated on these projects, as argued later, because of unduly low interest rates, the correction for which would further reduce the benefit-cost ratio of projects already executed, raises question that the assumption of capital rationing is realistic.

⁵As stated by officials of the IBRD and USAID, funds have been advanced for projects which they felt were of a very marginal nature; i.e. benefit-cost ratios of barely 1.0.

also a present value) does have the advantage that the computed rate of return is the maximum interest rate which leaves the project barely justified. The formula would be:

$$\sum_{t=0}^m \frac{B_t - C_t}{(1+r)^t} = K \text{ given } B_t, C_t, \text{ and } K \text{ solve for } r.$$

This method would satisfy criteria of all international financing agencies. Regardless of the interest rate charged by each agency at the time of the loan or if the rate changes between the time of evaluation and actual decisions, no additional calculations are required to bring the analysis up-to-date. Further, no adjustments in criteria are needed regardless of the agencies from which loans are sought. On the other hand, the ratio of the net discounted benefits to the capital cost is convenient in that, like the benefit-cost ratio, any rates of unity or higher justifies the project (at the assumed interest rate).⁷ The merits of both alternatives can be combined if that ratio is computed for several interest rates in the expected range of the relevant rate at the time of the decision-making. This is recommended as the most desirable method of summarizing the merits of a given project for subsequent financing from several alternative agencies each with different rates of interest and other criteria.

⁷Here the formulation suggested is the ratio of the value of the net benefits discounted by the accepted interest rate to the value of the capital investment. This ratio is greater than

$$\frac{\sum_{t=0}^T \frac{B_t - C_t}{(1+r)^t}}{K}$$

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Care must be made in interpolation of the rate of return for project design. Different rates of return are likely to characterize varying sizes of a project. It would be erroneous to attempt to design the project to maximize the rate of return unless that rate coincides with the relevant interest rate. Failing to expand the project beyond the point of maximum rate of return, if greater than the interest rate, results in additional investment foregone even though that increment will earn a return higher than the alternative use of the capital (as reflected in the interest rate). The project should be designed to equate the rate of return on the last increment of investment to the interest rate. Any increment to the project where net discounted benefits exceed costs is a superior use of resources than is presumably available elsewhere.

The Economics of Benefits

The benefits of any water resources project are a result of the presumed lower price and the increased consumption to the project output. This is evident from the well established theory that the quantity demanded of any particular good or service increases as the price declines, other things equal. Abstractly, these benefits can be rigorously defined and in most cases quite closely approximated in actual practice for water resource projects. In order to do so, however, it is necessary to introduce the concept of consumer surplus.

Let us take a hypothetical demand function relating the quantity of X that will be purchased in the market and the price of that commodity. This function may be depicted as D_x in Figure I. For lower relative prices of X_1 , larger quantities are purchased and consumed.

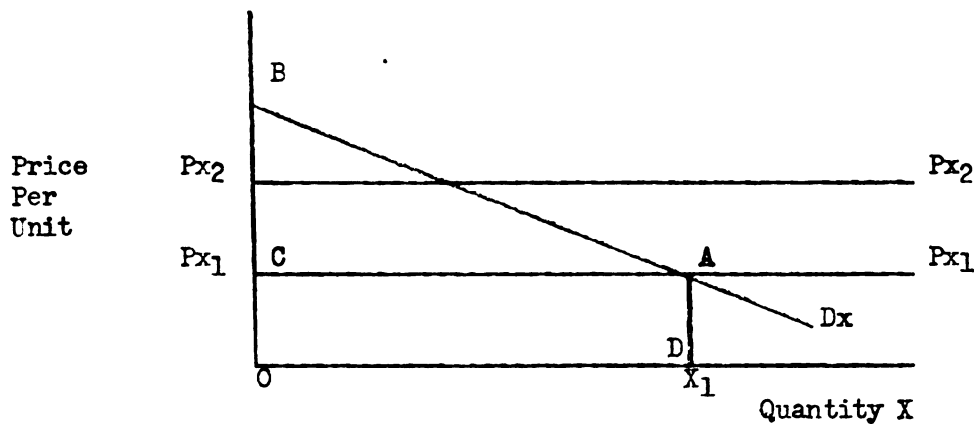


Figure I

The consumer satisfactions will be maximized at a quantity equal to X_1 for the price P_{x_1} . Relative to prices of other goods, the satisfactions from the last unit of X are just sufficient to offset the losses in satisfaction offered by not expending that amount on other goods. For amounts of X greater than X_1 , the satisfactions of the marginal unit decline relative to those of other goods, and conversely for smaller amounts. The amounts of X between zero and X_1 are extra-marginal units, and satisfaction offered by each is greater than the satisfaction that could have been obtained by the marginal amounts of other goods foregone. A smaller quantity will be consumed if the relative price of X was P_{x_2} , or higher than P_{x_1} . The difference between the price line, P_{x_1} , and the demand schedule, D_x , represents the consumer surplus gained by the individual because he is able to buy and consume varying quantities of X . If, on the other hand, he were offered the opportunity of buying X_1 or none at all of X , he would be willing to pay a price higher than P_{x_1} per unit. This is true because the sum of the satisfactions foregone by consuming no X (total value equivalent to the area bounded

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by $ABCO$) is greater than the satisfactions realized by consuming other goods, equal to the area $ACOD$. The consumer surplus, then, is the area ABC , and is equal to the difference between the maximum amount the individual would pay for the quantity X_1 where he must take all or none of it, and the amount he will pay if the price is equal to P_{x_1} .

The effect on consumer surplus of a reduction in price of commodity X is illustrated in Figure 2. If the price goes from P_{x_2} to P_{x_1} the quantity demanded increases from X_2 to X_1 . Total satisfactions from

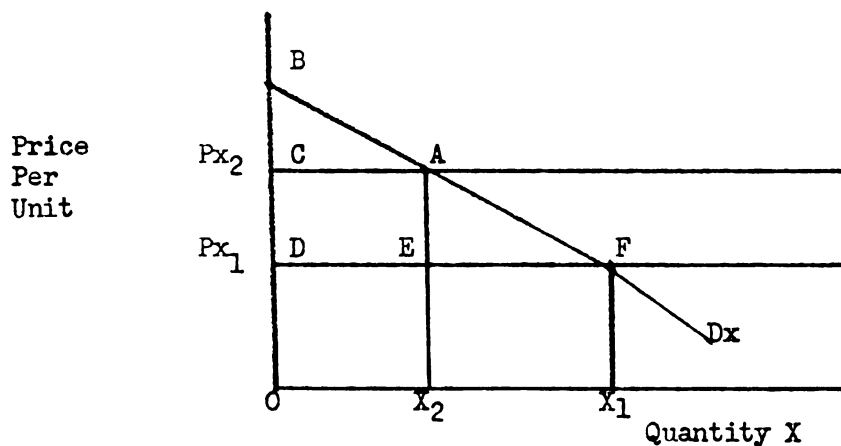


Figure 2

consuming X increases from $ABCOX_2E$ to $FABCOX_1$, or by the area represented by $FAEX_2X_1$. However, consumption of other goods increased by the area $ACDE$, and has been reduced by the area FEX_2X_1 . Therefore, the net gain in consumer surplus is the area $ACDEF$. If, for example, P_{x_2} represents the cost of producing electrical power by the cheapest alternative and P_{x_1} is the cost of hydroelectric power supply, in terms of consumer surplus, the net benefit of the power is the area $ACDEF$ and is equal to the price differential times the quantity that would be consumed at the higher price. The gross benefit is the net benefit plus

the cost of producing the power or the area $ODEFX_1$.

The line Px_2 is a cost line if it represents the cost of the resources required to produce a unit of power, and this cost is positive only because there are competing uses for these resources. If the power is produced, it follows that output of other commodities must be reduced, or fail to grow as fast as they otherwise would, and the height of the cost line, Px_1 , represents the value foregone in terms of these other commodities. No concept of cost other than that of alternative foregone elsewhere has any economic meaning, for if no alternatives are restricted, the resources employed must be abundant and free, and hence are not economic goods.

In Figure 2, if we let Px_1 represent the cost per unit of Federal power, for example, in terms of other goods or services given up, and Px_2 the same for the private steam power alternative. There will be net benefits to the power project, only if the resources required to produce a given amount of power via the project have a lower total alternative value to society than to the resources required for the private alternative source of power. The cost function summarizes conditions of supply in that it indicates the value to society of what has to be given up in order to have more of a specific good, while the demand function reveals what people are willing to sacrifice in terms of other goods and services, in order to consume that specific good. The area between the two functions represents the excess over what they are willing to give up and what they are required to give up, or consumer surplus.

The pertinent question is how well, in practice, is one able to

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measure benefits as increments of consumer surplus. The alternative cost approach is widely used in evaluations of hydroelectric power, navigations, and municipal and industrial water supplies. This approach will be a fair approximation of gross benefits (consumer surplus), if the demand function, relative to quantity demanded, is inelastic. If the demand is inelastic the relative change in quantity is less than the relative change in price and, therefore, the error is minor. Alternative cost will be a fair approximation of gross consumer surplus also if the differences in project and alternative source costs are relatively small. It is only an approximation because no allowance is made for the differences in quantities demanded under the true conditions of project supply and alternative supply.

It is common procedure in evaluating projects to predict the quantity of the good or services that will be demanded and apply both project and alternative supply prices to this single quantity. This is illustrated in Figure 3. The cost of the alternative source is considered to be the

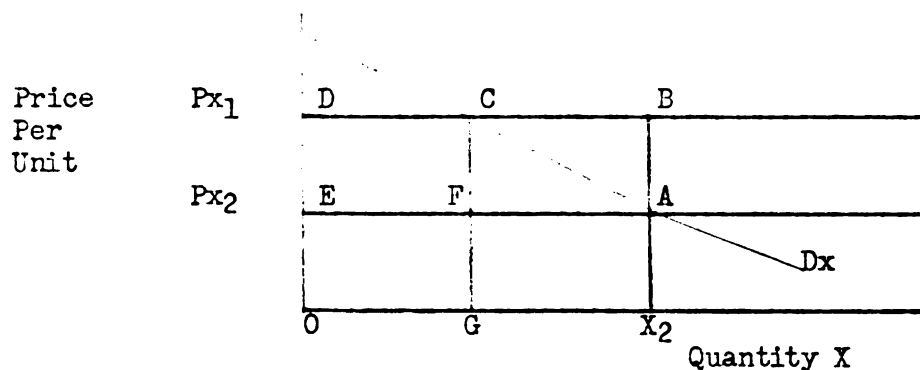


Figure 3

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would be OGX_2AFE , with $ABCDEF$ being the net benefit. This procedure results in net benefits being overestimated by the area ABC . The correct net benefit (consumer surplus increment) is the area $ACDEF$. If, however, D_x is very inelastic so that $X_2 - X_1$, relative to X_2 , is very small compared with $P_{x1} - P_{x2}$, relative to P_{x1} , the overstatement will be relatively small. Likewise, the larger is X_2 , given the differences in costs, or the smaller the differences in costs, given X_2 , the smaller the percentage error will be.

Two distinct situations must be distinguished in using the alternative cost approach to estimate benefits. First, where the project product is used as an input to the production of a final product and the price of that product is not affected by the project. This situation may characterize irrigation, especially in the United States, where the effect on the price of the agricultural products by the increased output of the project land is negligible. In this situation, it may be assumed that the benefit of the project function will be capitalized into some factor specific to the project area. Second, we can assume that the final product is produced by the project, and that the price of the project product will be less than the alternative product. Hydroelectric power, in some cases, and recreational facilities are examples of this type of product. However, these benefits are not necessarily easily identifiable in terms of capitalization into some fixed factor.

Application of Economic Concepts in Determining Project Benefits

The alternative cost approach is a reasonable approximation of the

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gain in consumer surplus and, therefore, an acceptable method for evaluation of power, and municipal and industrial water supply projects. The alternative costs for these water uses will not be drastically different from the project cost of each function. Conceptually, at least, the alternative cost approach can also be applied to the determination of benefits derived from flood control, irrigation and recreational facilities.

Flood Control

The relevant alternative cost for flood control is the cost of producing the services of the land in areas other than on the flood plain. These services may range from providing sites for residential housing and factories to agricultural production.

Let us consider a case where a change in land use occurs as a result of flood protection. If the installation of flood control makes possible the shifting of waste land into higher value urban or agricultural uses, the benefits are reflected in increased rents or land values. The flood control is essentially an investment on the land which increases its productivity for higher value uses. Since the area of land in the flood plain is fixed, the returns to the flood control investment will be capitalized into that factor.

The case where flood control involves no change in land use, but will result in reduced annual damage is quite similar. An example of this is a city partially located in the flood plain. The costs of producing the services offered by the land in the flood plain cannot be greater than alternative sources of those services elsewhere. Frequent flooding, which increases the cost of residential housing will result in

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lower land values in the flood plain, so that the total cost is consistent with the cheapest alternative. Reduction of the flooding will increase the rents to the flooded lands, as it reduces the other costs of production but not the cost from alternative sources. Because land is a fixed factor it is able to capture the benefits accruing from flood control. The non-rent costs of production are reduced, relative to costs from alternative sources, and this differential is capitalized into the land and is reflected in the increased rental value of the flooded land. In the case of no change in land use, the entire increment to land rents represent annual benefits to flood control.⁸

Benefits both from reduction in damage and changed land use will be reflected in changes in the value (or rent) of land in the flood plain as a result of flood protection. Care must be exercised, however, not to include the return to additional investments made on the land which may become feasible once flood protection is available. For instance, if the flood plain had no use before the flood control protection, but became a residential area thereafter, only the increase in the site value would be admissable as a benefit. The increase in value attributable to construction of housing, street, etc., would presumably have taken place elsewhere had the project not been executed, and therefore,

⁸Prices of factors other than land and fixed investment in land will be determined independently of reclamation investment since these factors are sufficiently mobile to have prices determined outside the agricultural sector. The mobility assumption with respect to pricing of non land factors implies that the returns from reclamation will either be capitalized into land value or paid in the form of construction charges assessed against the use of irrigation water and uses of the land protected from flooding.

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Irrigation

Irrigation is similar to flood control in that it is essentially an investment specific to a given tract of land and the benefits of the project will be reflected as increases in the capital value of that land. It is essential here also that the return to nonproject investments be excluded.

It is customary in evaluating potential projects to estimate the "repayment capacity" of the water user for the cost of the investment in irrigation. This would be a good measure of the benefit of the project, representing the whole of the value of the water to the user, if it included the entire increase in net income (apart from return to nonproject investment). This value is derived by determining the maximum amount the farmer could pay for a given amount of water for each soil type on his farm. If this is properly done, the amount represents the entire area under the demand curve for water, and if it were actually collected from the farmer in return for water, his net income would be no higher than before irrigation.

Thus, repayment capacity calculations offer a method of estimating the total consumer surplus available for given amounts of water. However, since different prices are charged for the same product, price discrimination is implicit in the calculations, and it is necessary that price discrimination be used also in the actual allocation of the water. But if the farm consists of several soil types with different productivities, and if the water is sold at a single price, the result will be that the farmer will choose to use less water than is expected, and repayment will

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fall short of expectations. This is because, at the single price of water, some of his land is of sufficiently low productivity that it is not feasible to irrigate it; whereas the repayment capacity and hence the price of the water assumes a declining schedule of water value.

The maximum repayment, then, should be a good estimate of the benefits attached to irrigation development, but are very likely to be optimistic of estimates of revenue to be actually received from the water users if the water is sold at a single price per farm.

Recreation

Recreation facilities provided by a water resource project fall into a category of benefits of a final product nature. Any benefits attributed to this function must be a result of the price of the project output being less than that of the alternatives. The difference in costs of the project product and the alternative must be known to estimate these benefits. The area bounded by these curves and the demand curve for the product will be equal to the benefits, in terms of consumer surplus, of this function of the project. There are difficulties in estimating these two prices or costs, even though it is possible to determine the increase in use. Assuming a linear demand function, the benefit would be equal to one-half the increased use of recreational facilities times the reduction in cost (this is strictly true only if utilization was zero before the project).

The way to approximate these benefits without having explicit knowledge of prices is suggested. If there is a real reduction in the cost of obtaining recreation by the project, it will be worth an amount equal to that reduction in order to use the nearby project reservoir

rather than go elsewhere for an alternative body of water. That is, one will pay a rent in order to use the reservoir. If there is competition for the exclusive use of the water, (e.g., frontages sold on the open market), one will be willing to pay an amount for the frontage equal to the cost reduction to him of not having to go elsewhere. The rent on a particular frontage will depend upon the extent to which other costs are less there than for the alternative, whether the alternative be on the same reservoir or on another lake. Frontage which is able to earn no rent will have no benefits, as the absence of rent indicates that it has no advantage over alternatives; people are indifferent between using that frontage or going elsewhere.

Rents earned by frontage property, then, are a reasonable estimate of the benefits to the recreational aspect of a project, however, estimation of these rents is not an easy task. A rough approximation may be made by determining frontage values of similar reservoirs. A more sophisticated approach would be to take into account the effect of differences in population, income, availability of substitutes, and quality of the reservoir on the price of the frontage in a cross sectional analysis.

No evaluation method based upon benefits being equal to alternative costs can be accepted unless identical treatment is given to interest and taxes foregone for both the project and the private alternative. That is, the government project should not be given a preferred status with respect to these items. If the alternative is privately financed, the resources it would utilize would essentially be producing two products. For example, in the hydroelectric power case, the private

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alternative will produce power as well as government services in the form of tax payments. The public project will pay negligible taxes; hence its output is, for practical purposes, all power. Unless tax payments foregone are included as a cost of the project, or taxes are removed from the cost of the alternative, we will be comparing dissimilar items, and the analysis will be biased in favor of the public project. Alternatively, if the costs of the alternative are to be reduced by taxes to put it on a basis comparable to the non-paying Federal project, all taxes should be removed. Likewise, treatment of interest costs must be comparable for the project and the alternative. The effect on evaluation of projects, using different interest rates is treated in detail in the next section.

Critique of Secondary Benefits

The concept of primary benefits accruing to a water resource project is generally obvious, even though their exact nature and the proper method of measuring them may be difficult to ascertain. Likewise, it is equally obvious that secondary activities in the area of the project will usually be stimulated and expanded as a result of the primary resource development.

The extent of the "area" cannot be precisely determined, for it is possible for the effects of the project to be felt throughout the whole economy. If we assume that these secondary effects can be identified the question, then, becomes whether there is anything inherent in this additional commercial and industrial activity, such that the welfare of a Nation is increased in this particular use of project resources. If

so, then it is clearly desirable to include some measure of this beneficial aspect in determining whether to proceed with the project. Conversely, if these secondary aspects are undesirable, there is less reason to adopt the project. The argument to this point is essentially that if net secondary benefits to the economy do exist, they should be evaluated as carefully and precisely as primary benefits. Granted their existence, they are just as real and important to the evaluation of the project as other benefits and they should not be viewed ambiguously, as a class of benefits for which only partial consideration be granted.

Secondary Benefits - Practical and Analytical View

The general view of secondary benefits has been to consider their net value; that is, the gross secondary benefits have to be offset by secondary cost, the exact composition being somewhat in dispute. There are certain implication of this point of view relative to benefit-cost ratios which have not been clear, and has not been used correctly in many project evaluations.

If the particular value of a benefit-cost ratio has any relevance other than whether it is greater than unity, the manner in which secondary benefits are included in the calculations can lead to different results. For example, assume that the following estimates are determined for a water resources project:

Annual primary benefits	\$150.00
Annual primary costs	100.00
B/C ratio	1.50
Annual secondary benefits	100.00
Annual secondary costs	75.00
B/C ratio (Secondaries only)	1.33
Net annual secondary benefits	25.00

It is seen that the benefit-cost ratio on the basis of primary benefits

and costs is 1.5. If net secondary benefits are added to primary benefits, the ratio becomes:

$$\frac{150 + 25}{100} = 1.75$$

Calculating in this manner must increase the benefit-cost ratio as long as there are net secondary benefits -- the opposite is true if there are net secondary costs.

If the ratio is calculated by adding the gross secondary figures to the primary benefits and costs the ratio is:

$$\frac{150 + 100}{100 + 75} = 1.43$$

Here the ratio is reduced from the original 1.5 and is much less than (1.43 to 1.75) using simply net secondary benefits in the ratio. In general, where the ratio of secondary benefits to secondary costs is less than the ratio of the primary estimates, then the composite ratio will be less than the latter and marked by less than the ratio using only net secondary benefits. The extent of this divergence will depend on the size of the secondary estimates relative to primary benefits and costs. For example, let the secondary benefits and costs be three times as large as before, then, the figure would be:

Annual primary benefits	\$150.00
Annual primary costs	100.00
B/C ratio	1.50
Annual secondary benefits	300.00
Annual secondary costs	225.00
B/C ratio (Secondaries only)	1.33
Net secondary benefits	75.00

Calculating the benefit-cost ratios we get the following results:

$$\text{Primary benefits only } \frac{150}{100} = 1.50$$

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$$\text{Adding net secondary benefits } \frac{150 + 300}{100 + 225} = 1.38$$

Two important points are noted. First, by increasing the relative size of secondary benefits and costs, the composite ratio for the project is reduced from 1.43 to 1.38. Second, just adding net secondary benefits to primary benefits the ratio increases to 2.25 from the previous 1.75.

It is argued here that the logical procedure is to add the additional benefits and costs to primary benefits and costs, respectively, before calculating the ratio. The results of not doing so is obvious. If projects with identical total benefits and costs, but with a different division between primaries and secondaries, were being analyzed, the project with the relatively greater secondaries would produce the greater ratio where net secondary benefits are added to primary benefits. It would be ridiculous to give a higher rating to one project when it has the same overall effect on the economy.

The difficulty in this approach of secondary benefits lies in estimating the secondary costs. The question is what allowance should be made for the net secondary benefits which would have been realized if the project resources had been used elsewhere. That is, if the project was not undertaken, we can assume that the resources intended for it would be used elsewhere in the economy, and be expected to generate primary and secondary benefits in these alternative employments. Hence, the use of resources in a particular project means that the possible alternative benefits are given up — the cost of the project in a real sense is the value of these foregone benefits.

It is sometimes assumed that the value of all foregone benefits are included in the market price of the project resource and hence, only the costs of resources in the secondary activities need be considered. In other words, no allowance need be made for the foregone secondary benefits which would arise from the alternative use of the project alternatives. But, suppose the situation is reversed, what would be the price required of the alternative investment to bid these resources away from the project? Clearly, this would be determined by the value of the goods and services rendered by the project resources; essentially the gross primary benefits of the project. The pricing process is reversible, and so it would be inconsistent to claim that the market price includes the value of secondary benefits. The value of goods and services is determined by demand and supply within their relevant market.

Secondary Benefits From Project in Less Developed Countries

The usual explanation of how secondary benefits arise is that otherwise unemployed resources will be used or some resources will be utilized more efficiently. But under conditions of full or near full employment of resources, there is no evidence or presumption that this problem is more crucial than in the area from which project resources are drawn. That is, we do not know how inefficiently employed resources are distributed throughout the economy, if in fact such a situation does exist. Consequently, in this situation it is recommended that secondary benefits not be included in the evaluation to determine whether or not a project should be built.

The question of chronic unemployed resources, such as is the usual

case in less developed countries, is somewhat clearer. Here, the unemployed resources are less mobile and cannot be absorbed elsewhere over time and other public policies and programs are less appropriate and efficient. The scope for economic development is limited by the pressures for consumption and, hence, by the difficulties of providing resources for investment, by institutional framework, and by lack of skills. The unemployment or under-employment is persistent and food shortages and low levels of living are the usual case.

It is contended that the secondary effects of water resource projects are relatively more important in less developed countries than, for example, in the United States. A brief discussion of the principle concepts involved follows.

Most of the economic writings on the theory of resource development argue that investments in developmental projects such as water resource programs are of the nature of autonomous investments with powerful induced investment potentials. That is, the original investment in putting water on the land is only the beginning of the total investment process. Houses and farm buildings must be constructed, roads and railroad facilities must be extended into the area, additional processing plants and marketing facilities are needed, etc. and the full impact of such developments results in a total investment of many times the original one. However, the degree of induced investment which would accrue to the general economy from autonomous investments in water resource projects are greatly influenced by the true shape of the investment program and the conditions of the economy. Under certain conditions the investment may be highly beneficial but, under other

conditions it may be positively harmful. This is because all autonomous investment has within itself an element of development and an element of competition as it affects the entire economy.

If the competitive influences are the more pronounced the result of the investment will be deflationary in its effect. If the competitive influence is less pronounced than the developmental elements, the effect of the investment on the economy as a whole will be inflationary. Whether the deflationary effect of a sudden increase in production unaccompanied by a large autonomous investment is beneficial or not depends upon the conditions of the economy at the time the production increase occurs. If a sudden increase in production occurs at a time when autonomous investment is weak or even decreasing, the increase in production and accompanying decline in prices will lead to a decrease in national income, and will even worsen an otherwise weak position of the economy.

It is contended here that water resource projects in less developed countries would, in most instances, have maximum beneficial influences on economic development of the economy. The initial investment occurs usually under conditions of widespread underemployment and low utilization of resources. In the construction operation itself serious competitive effects are not as likely to be experienced by the economy. Labor is put to work which otherwise would be unemployed and new skills are learned in constructing and operating projects that would otherwise remain unskilled. Resources are used which otherwise would go unused. The multiplier and accelerator effects of the investment will raise employment and incomes generally without serious detriment to any particular sector of the economy. Finally, new production occurs where

there is a scarcity of agricultural commodities so that the effect will keep prices from becoming inflationary.

Under these favorable conditions, which are met, for the most part, in less developed countries, the benefits of irrigation and other water uses are maximized. Because of these conditions it is contended that greater consideration to secondary benefits from water resource projects in less developed countries is warranted, and should be included in project evaluations. This would justify government subsidization of feasible resource projects which are not financially feasible because of incapacities of subsistence type agriculture and inabilities of peasant farmers to assume responsibility for reimbursement of project costs within the limits specified by international financing institutions.

Interest Rate Considerations,
Implications and Recommendations

The interest rate, as a cost of capital, used in investment decisions reflects the preference of lenders for current over future consumption,¹⁰ the alternative uses of the resources, and risk premium to cover variability of expected returns inherent to an investment. It fulfills two primary and related roles in project evaluation, first, it distinguishes among projects, with respect to the time shape of the costs and benefits and the level of those benefits relative to capital inputs. Secondly,

¹⁰This is the concept of time preference which is defined by the reaction of an individual of perpetual life (and income stream) to a zero interest rate. If that person has zero time preference, he will consume the same amount each period, that amount being equal to his average income. With positive time preference, he would borrow so as to consume more; with negative time preference he would save.

within one project, the rate of interest, together with the prices of capital and operating goods and the transformation function by which we can technically substitute one for the other, determines the level of capital intensity.

It was pointed out previously while the benefit-cost analysis allows the interest rate to allocate between capital and non-capital expenditures within a project, it favors capital intensive projects relative to a rate of return analysis. The result is similar to a situation where one rate is used for decisions internal to the project, but another and effectively lower rate for choosing among projects.

Opinion among authorities on the correct interest rate is divided. Current practices in the United States in terms of the choice of interest rates for project evaluation is intended to approximate the borrowing rate on long term loans. That rate, by its very nature, contains no risk premium, as lending to the Government is riskless, apart from risks of changes in the price level. As one authority indicated, the Government through its power of taxation, has unlimited claim to the resources of the society and in effect guarantees each loan with these resources.¹¹ Therefore, if the Government borrowing rate represents the value of these resources in alternative and riskless uses, it is an insufficient rate for application to a project where risk is not negligible. The same principles and arguments apply whether we are comparing differ-

¹¹Arnold Harberger, Papers of Joint Economic Committees, "Federal Expenditure Policy for Economic Growth and Stability", U.S. Government Printing Office, Washington, 1957, p. 239.

ences in rates between the United States Government and the private markets or between different international financing agencies for projects in less developed countries.

One authority argues that the correct interest rate is the "social rate of time preference" of taxpayers.¹² He assumes that purchasers of Government bonds are not financing water resource development, and thus it is the taxpayers' rate of time preference (estimated to be between 5 and 6 percent) which represents the real social cost of capital for this use. However, it would be most difficult to determine who is financing water resource projects, whether domestic or foreign. One could argue that tax proceeds are used partially to retire Government debt, and pay interest thereon, and that proceeds of bond sales finance water resource development, the implication being that the bond rate (plus risk premium) is the relevant one for these projects. This

¹²Otto Eckstein, Water Resource Development, Harvard University Press, Cambridge, 1958, Chapter III. While Eckstein believes the social time preference rate of taxpayers in the U.S. to be 5 to 6 percent, he feels that this rate is unduly high for Government investment because; (a) a lower rate is relevant for Government than for private decisions; (b) Government investment is at a disadvantage relative to private investment, since no depreciation allowances are available on the former; and (c) private decisions are biased towards relatively short-lived investments. He offers these arguments as a rational for a compromise utilizing a relatively low interest rate but adding the requirement that the benefit-cost ratios be well in excess of unity. This is questioned because if imposed, this scheme would clearly cause an increased distortion within projects as compared to among them. Internally, the inputs of a project would be determined by the 5 or 6 percent interest rate, while a lower rate would be implicit in choosing among projects. It is contended that if a lower interest rate is called for, it should not be nullified by requiring a high benefit-cost ratio which at the same time distracts the project choice relative to the input requirements. If the 5 or 6 percent were the correct one, it should be applied unequivocally. Therefore, this compromise does not appear to be acceptable.

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argument is equally difficult to maintain. It is argued here that the long term Government borrowing rate in the United States represents the value of resources in riskless uses elsewhere in the economy and thus is clearly the rate to be used in drawing resources from these uses, after taking risk into account.

Effect of Different Interest Rates

The agencies that analyze various aspects of water resource projects in the United States, and international financing agencies use different interest rates, the particular rate depending upon the agency and the individual project in question. Changes in the interest rate for analysis by benefit-cost ratios and by rates of return have significant implication for evaluation of projects.

An increase in the interest rate used in evaluation of a project has the internal effect of lowering the capital intensity of that project, the extent depending upon the transformation function of that project. In general, a rise in the interest rate will be accompanied by substitution within the project towards lower capital intensity, assuming that in the real world we have a condition existing between fixed proportions and perfect substitutability.¹³

With respect to whether benefit-cost ratio or rate of return analysis is used for project evaluation, the effects internal to the project of changes in the interest rate are the same. This may be

¹³That is, assuming that this condition is more usual than having fixed proportions at one extreme, where the capital intensity is not altered; and, at the other extreme, where operating goods and capital goods are perfect substitutes and a range of interest rates over which there will be no change in capital intensity, but beyond a certain point where capital is completely replaced with operating goods.

demonstrated as follows: If we let B equal annual equivalent benefits; O equal annual operating costs, K equal capital investment and $a_{iT}K$ equal annual interest and amortization costs, we have $B/C = E / (O + a_{iT}K)$ for benefit-cost ratio. The denominator will be minimized (the ratio maximized), when a transfer of goods from O to K can no longer reduce total annual costs of achieving the level of benefits, and that point depending on a_{iT} ,¹¹ the relative prices of capital and operating goods, and the transformation function between O and K. Any change in the interest rate will change a_{iT} , thus indicating a reallocation of resources between capital goods and operating goods.

In addition, changes in the interest rate will alter the scale of the project. Likewise, the present value of a project is maximized when the last increment of benefit is equal to the last unit of cost (present values). If that benefit can be had at a lower cost by transfers between capital and operating costs, present value is maximized. Therefore, the scale and input combinations of the project are altered until the condition is satisfied. The interest rate will thus affect both scale and combination of resources used.

Changes in the interest rate can also affect the ranking of projects when ranked by benefit-cost ratios. If projects have about equal rates of substitution on the relevant portion of the transformation function but widely varying degrees of capital intensity, their ranking by present value analysis will be unchanged over variations in the interest rate, while the ranking by benefit-cost ratios can be completely altered

¹¹As determined by project life and the interest rate.

(assuming scale of project is altered but little, otherwise the present values may also be volatile and their ranking could be altered).

Consider the case of fixed proportions within the project with respect to capital and noncapital inputs, but proportions which vary widely among projects. Apart from scale considerations, the present value of net benefits are reduced by a rise in the interest rate but the amount of capital is unchanged. Further, the present value of all projects are reduced by the same percentage, so the original ranking is preserved (assuming similar time shapes of income stream).

Now consider a highly capital intensive project and one also of the opposite nature. The benefit-cost ratios will change significantly, relative to one another. With a rise in the interest rate, the ratio for the capital intensive project will drop substantially, while the ratio for the opposite type of project will be altered but little. Hence, their rankings could be easily reversed. It is conceivable that one project with a ratio above unity at one interest rate could be below unity at a higher rate, while a second with a ratio below that of the first at the lower interest rate would remain justified at the higher rate. However, as was pointed out above, the rankings serve to aid decision making only if capital rationing exists, in which case the benefit-cost ratio rankings are preferred.

Different Interest Rates for Benefits and Costs

The manner in which nonuniform benefit and cost streams are reduced to annual equivalents can have a pronounced effect upon their relations. The particular level of benefits or costs arrived at in annual equivalents, will depend upon actual benefits or costs during

the period of analysis, the shape of the time stream of those items, and the interest rate used. Presumably, only the interest rate can be a variable to the particular agency or institution making the evaluation since the level and shape of the benefits and costs is determined by other factors.

It makes no difference what interest rate is used to convert uniform streams of benefits and costs to annual equivalents. Proof of this is as follows: Let B_t equal benefits of year t , and r equal the interest rate employed. The present value of a stream from

$$t = 1 \text{ to } T \text{ is } \sum_{t=1}^T \frac{B_t}{(1+r)^t}. \quad \text{Dividing by } \sum_{t=1}^T \frac{1}{(1+r)^t},$$

we have the annuity which the present value of the benefits will provide T years with an interest rate of r . If B_t is a constant, it can be factored out, the rest of the expression cancels, leaving annual benefits $= B_t = B$, independent of r .

Suppose, however, the benefits accrue primarily in the final years of the period of analysis.¹⁵ The higher the interest rate, r , the smaller the present value of the stream. This smaller present value is carried forward at the higher interest rate but the amount of benefits to be "amortized" is reduced by the higher rate. Thus, the higher interest rate results in annual benefit equivalents being less than they would have been with a lower rate from a stream of a given pattern. In other words, if the stream of benefits is increasing over time, the

¹⁵This situation particularly applicable to projects in less developed countries where high productivity is dependent on application of new technology, new varieties of crops, and improved management aside from the factor of water.

higher the rate of interest used to compute annual equivalents, the lower will be those annual equivalents. This same relationship is true for the stream of operating costs.

When the stream of benefits decreases over the period of analysis, the higher the interest rate used, the higher the annual equivalents. In this case, the high rate at which the early larger benefits are carried forward more than offsets the smaller value which is amortized.

The significance of this is that for any given project, the benefit-cost relation can be altered by use of different interest rates in the seemingly straight-forward calculation of annual equivalents. This supports the contention that the ranking and feasibility of projects is not independent of the agency making the evaluations or assuming the responsibility for financing.

Recommended Interest Rate

It is argued here that projects should be evaluated at the current interest rate because it is the best indicator of the value of resources for alternative investments. The interest rate recommended by the Federal Inter-Agency Committee on Water Resources is the average of "coupon rate" on outstanding government bonds which, at time of issue, has a maturity above some minimum.¹⁶ The relevance of the interest rate on issue (not the current yield rate) of bonds issued twenty or thirty years ago is presumably based upon some notion that interest rates tend towards some norm and that if one takes the average over a long enough

¹⁶"Green Book", Op, Cit. p. 24, The Bureau of the Budget following its own A-47, Section 15, recommends an average interest rate currently set at 2 7/8 percent.

period, he will better approximate the normal and "natural" value. This practice results in a frustration of the markets' attempt to achieve the optimal allocation of available resources among consumptive and nonconsumptive uses over time.

The level of interest rates in the past is determined by the relative scarcity of resources for investment and the spread between rates, at a point in time, reflect expectations of rates to prevail in the future. It is difficult to conceive how past levels and structure of rates, of varying maturities, can convey any additional knowledge about the future. These rates reflect past conditions and past guesses about the future and cannot be superior in anyway to information contained in current rates. On the other hand, the current yield on past issues is relevant, as they are perfect substitutes for current issues of similar maturity: It would appear without reason when evaluating water resource projects to use interest rates different from currently realized rates (or yields) on debt instruments of risk and maturity similar to the anticipated benefits of the project in question.

The question is to determine the correct current interest rate to be used, or preferably, the schedule of rates to be used. (Actually, the yield rather than the coupon rate is the proper term). Bonds are usually issued at varying maturities, i.e. five, twenty-five, forty-years, etc. For any particular government agency or legal entity, there will exist a schedule of interest rates pertaining to the different maturities. The structure of rates within any schedule will generally be one of higher rates for the longer maturities. Consequently, though preference is made to the Federal government rate, the municipal government rate, the corporate

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bond rate, etc., the more correct reference is to a different schedule of rates. Now, if water resource projects were risk free, the Federal government schedule of bond rates would be the appropriate one. However, since this is not the case, these particular rates can only be considered as the absolute minimum. Clearly, there is risk attached to water resource projects, and no matter how much precision is used in evaluating benefits and costs, projections so far in the future subject the estimates to risks of unforeseen circumstances. It is not possible, moreover, to determine the variability of errors in these evaluations, but what can be determined is society's estimate of this variability when the function is performed by the private sector of the economy. This is incorporated into the interest rates on private borrowing, a positive risk premium being added to the pure riskless rate. Unless there is reason to believe that government evaluation is either better (or worse) than that of the private sector, the risk premium should be the same in either case.

Although private industry is not usually involved in projects of this type there are several classes of private borrowing which most nearly will reflect approximately the same risk. These are the AAA corporate bond issues which enjoy preferred status, as much of the risk is borne by the common stock of the corporation. A similar argument can be made for most classes of AAA corporate bonds; their interest rate will reflect a risk premium less than that required to cover the risk associated with the enterprise. Ideally, the schedule of rates would be chosen that best reflects the risk consistent with water resource projects. However, there is little in the private sector of the economy which closely resembles these projects. The risk of water resource projects is at least as large

as that of AAA corporate bonds, consequently, it is recommended that no rate less than these be used because they represent the minimum risk in the private sector and are very unlikely to overstate the risk involved. Yields on AAA corporate bonds in the United States averaged about 4.5 percent of yields for varying maturities in 1963.¹⁷ This amount is approximately one percent above the rate charged by USAID, and $1\frac{1}{4}$ percent less than charged by the IBRD.

The preferred procedure to apply the interest rate is to discount each years' benefits (costs) by the relevant maturity yield, in which case the effective rate is determined by the time streams, rather than applying the simple average to all benefits. Concentration of the benefits in the latter years of a project would result in a higher effective rate than would a uniform stream. This is appropriate because such a project is less desirable than one of more immediate benefits.

Inadequate capital markets in less developed countries precludes determination of corporate bond yields for use in evaluating water resource projects. Rates now used by international financing agencies are most applicable to those in the United States where the major portions of the funds for foreign investments are obtained. In the case of USAID, interest rates used are the borrowing rates on long-term United States government securities which contain no risk premiums, and for IBRD the rate is equal to the borrowing rate on alternative investments in the private sector. Hence, the recommended rate of yield on AAA corporate bonds in the United States would not be inappropriate for evaluation of water resources projects.

¹⁷Wall Street Journal.

The Effect of Different Periods of Analysis

The effect of different time horizons on a specific project is similar to that of different interest rates for capital costs. If both benefits and operating costs are uniform over the actual life of the project, shortening of the period of analysis will not, in the first instance, alter benefits with respect to costs because annual equivalents equal actual annual values. However, arbitrarily shortening of the period of analysis relative to the actual life of the projects results in internal shifts of combination of resources used; the project becomes less capital intensive. For instance, if the denominator of the benefit-cost ratio is $0 + a_{1T}K$; shortening the life shortens the amortization period, hence a_{1T} increases implying a reallocation of resource away from capital and in favor of operating costs. Further, the value of the denominator must decrease as the amortization period is shortened if it was previously at a premium; and the numerator, annual benefits, undergoes no further change. Hence shortening the period of analysis lowers benefit-cost ratios, the extent depending upon the degree of capital intensity and the degree to which operating inputs can be substituted for capital inputs.

The problem is complicated if benefit and operating cost streams are not uniform. Other things being equal, an arbitrary reduction in the period of analysis will favor projects whose benefits are concentrated in early years and/or operating costs in later years, and vice versa.

A shortening of the period of analysis will descriminate against projects where (a) benefits are an increasing function over time; (b) operating costs are a decreasing function over time; and (c) capital costs

are large relative to operating costs. If operating costs and benefits are fairly constant over time, the main effect upon a benefit-cost ratio in reducing the period of analysis is to increase annual costs because of the larger charge for amortization of the first cost.

In a present value calculation, the effect comes from the reduction in present value of benefits and operating costs. For example, suppose an annual benefit stream of \$1. The present value of that stream for the next 50 years is \$18.26; for 100 years \$19.85; and for an infinite stream \$20.00 at an interest rate of five percent interest. Even if the project had an infinite life, the percentage error in arbitrarily assuming a 50-year life is but 8.7 percent. Assuming a 50-year life for a project of actual life of 100 years results in an error of 8 percent.

Suppose we have a project where the operating costs and benefits are constant over time, and that the costs amount to one-half of the benefits. Also, assume the project has an actual life of 100 years, but we neglect all benefits and costs after 50 years. For each \$2 of gross benefit, the net benefit per year will be \$1 after deducting operating costs. This dollar for 100 years at 5 percent will just offset a capital cost of \$19.85. By limiting the time period to 50 years, the discount rate must be reduced to about $4\frac{1}{2}$ percent in order that dollar benefits have a present value of about \$19.85 (at $4\frac{1}{2}$ percent, the present value is \$19.76). Thus the effect of reducing the time period from 100 to 50 years is identical with reducing the rate of return from 5 to $4\frac{1}{2}$ percent. Thus, the importance of the time period is not independent of the general level of interest rate assumed. The higher the interest rate, the lesser the effect of reductions in the time horizon.

Time horizons used in evaluation of water resource projects range from 50 to 100 years. It is not clear that a unique time horizon is desirable for all projects as used by most agencies. Surely, the economic life of projects varies, and since the combination of products produced is often quite different, the uncertainty attached to future returns is not the same. However, our present ability to predict the future causes even a 50 year time horizon to appear hazardous. In order to adequately predict future returns, we must be able to predict future populations, incomes, composition of national output, supply of substitute products, regional growth, technology, etc. It is obvious that we cannot justify commitment of resources to uses where the return is extremely uncertain when shorter run investments of comparable returns are available. In choosing between two projects of equal return per year we should clearly favor the shorter project. It can be concluded that any period of analysis longer than fifty years would be ill advised.

Price Level and Relative Price Changes

An important aspect in water resource evaluation is the extent to which the current level of interest rates and other prices is affected by anticipated inflation or deflation. The simplest kind of inflation (deflation) occurs when the prices of all goods increase (decrease) by the same percentage; i.e., relative prices are constant but the price level rises (falls). A more realistic inflation is where changes in relative prices are experienced, but also the price level is increasing. Finally, there is the case where relative price changes occur, but the price level is unaltered. This latter situation is the most troublesome

in projection evaluation. The first (no change in relative prices) needs to be dealt with only to the extent that the future changes in the prices are anticipated and reflected in the interest rate. If the future price level is expected to be the same as the current one, the interest rate will reflect only time preference and a risk premium. If, however, it is anticipated that the price level will rise at X percent per year, the interest rate will also increase to compensate for this reduction in the purchasing power of money.

From past experience in the United States, we cannot be certain that current interest rates are affected by anticipated prices increases; to do so, one must first argue that the general price level has been increasing in the relatively recent past; and secondly, that this price level increase is being extrapolated into the future. While the price level (as computed by the Department of Commerce) has shown considerable advance since the Korean War, it is not clear that we have experienced actual inflation. Although the average annual rate of increase in the consumer price index since 1953 is about 1.5 percent, this may be due primarily to changes in the composition of goods and services, and changes in the quality of goods which have offset the changes in their prices. Thus, if expectations of future price changes in the United States are based upon the Consumer Price Index, it is possible that current interest rates reflect some adjustment for anticipated price increases; on the other hand, if expectations are formed by a more complex process, one would have difficulty defending the position that the current interest rates are noticeably affected by expected price level changes.

For purposes of project evaluation, it appears that the most

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reasonable assumption is that the future price level will be the same as the current one. This assumption implies that the interest rate used should not be adjusted for any inflation or deflation expectations. The current interest rate is chosen since it best reflects intertemporal values at the time the resources are committed. Likewise, the price for the capital goods must reflect the value of those goods at the time they are used for the project. It is concluded, therefore, that most projects are of sufficiently short construction period that current prices are the most acceptable.

One need be concerned much more about changes in relative prices when evaluating the benefit and operating cost streams. Of very great importance is the changes in the value of one good measured in terms of others. Secular trends in the cost of production of various goods have resulted from changing patterns of demand, technological innovations, government policy, etc. Thus, benefits and cost projections over a period as long as 50 years must include expected price changes, particularly if the output is highly concentrated into one or two primary products.

Much uncertainty surrounds benefit estimates from projects in less developed countries due to our inability to forecast specific prices with accuracy. Current prices are being manipulated by government, and for some products (particularly for staple products in deficit supply, such as wheat in Pakistan and rice in Guinea) exceed the world market price. Sudden and extremely significant changes in future prices could result as a result of large changes in agricultural production, disposable income, etc. In these instances world prices would be more appropriate for project evaluations.

Consideration must be given to current abnormalities in the price structure, and speculate to some extent about the forces influencing price behavior in the long run. We can bring to bear knowledge of past trends but simple extrapolation of those trends is certainly questionable. Each situation must be analyzed individually.

The conclusion is substantially that, in most cases, current prices are our best point estimate for the future because of lack of tools with which to predict with conviction. The problem of what is "current" will be influenced by characteristics of the seasonal and short-run price fluctuations. Any reasonable price prediction for the future must aim at essentially the average price, and not be influenced by a particular price rise or fall which will be short-lived. For projects currently being planned in less developed countries, an average price of the preceding five years is recommended, apart from the obvious situation where such a "current price" is unrealistic. Care must be made to obtain the average prices received by the farmer. This may require that prices received during the months of the year when the products are marketed be used for evaluation if it appears more realistic of future conditions. Other adjustments to prices may be necessary to reflect anticipated marketing conditions, government policy, and other situations.

CHAPTER V

OBSTACLES TO EVALUATION OF WATER RESOURCE PROJECTS IN WEST PAKISTAN, GUINEA AND URUGUAY

Understanding the National Environment

Understanding resource development work and understanding the goals of a society and its institutions are necessary for evaluation of potential projects. Individual project evaluation must be complemented by coordinated investigations of public welfare aspects of a project from regional and national perspectives. The obstacles faced by the investigators differ as a result of differences in the socio-economic conditions existing among the developing countries which cannot always be overcome with application of uniform stereo-typed standards and procedures at the individual project level.

National economies are at many different stages of economic development. There are different stages of economic and social development between these countries, and also among the economic sectors within each economy. But the stages of development or underdevelopment in any country, and the problems that restrict resource development and overall economic growth are manifestations of its economic, social and institutional structures. The problems encountered reflect, not simply affect its business structure and practices, government mechanisms and policies, the encrusted situations and practices in agriculture, and the religious beliefs, education, history, culture and traditions of the people.

Some of the obstacles to potential water resource development and

evaluation that were encountered in West Pakistan, Guinea and Uruguay are presented in this chapter. Many of the conditions found in these countries are believed to be typical of conditions prevailing in other less developed countries of the Middle East, Africa and Latin America.

Similarities in Socio-economic Conditions

Although the stages of economic and social development are at different levels in West Pakistan, Guinea and Uruguay, there are significant similarities existing among them which are typical of most less developed countries. (1) Agriculture is the principal economic activity. A subsistence type of agriculture prevails in West Pakistan and Guinea while an export-based agriculture predominates in Uruguay. (2) Manufacturing and processing activities tend to be relatively undeveloped and of unsophisticated varieties. (3) Managerial skills are scarce, contributing to serious unbalanced use of resources. Labor is abundant at low wages, average personal incomes are low, and underemployment and unemployment are high. (4) Agricultural productivity per acre is low and farmers have limited and crude tools for production. (5) Credit is costly and is not normally used to finance agricultural production. (6) Costs of production inputs per unit of output are high. (7) Although farm products do move to the markets, there is only a small back-flow of supplies and goods to the farms. (8) There is relatively little savings or capital formation and foreign exchange is scarce, especially in West Pakistan and Guinea.

In many respects the social environment in these countries is similar also. The people are divided into sharply separated groupings. These

separations are innumerable as a result of the product of distance due to lack of transportation and communications, lack of social association in common undertakings and national interests, and lack of education. Especially in West Pakistan and Guinea, these divisions are multiplied and broadened by different languages, religions, traditions, racial and tribal origins and various kinds of social stratifications.

Excluding Uruguay, nutritional levels in these countries are low, housing is extremely poor, schooling for some children is only beginning to become available, and illiteracy is widespread. Such higher education as has been available in the past to the relatively few has tended to emphasize learning for enhancement of status and prestige rather than for productive application. The health of the people is poor, their vitality is low, and birth and death rates are high.

Effective institutions to serve development needs, especially in West Pakistan and Guinea, either have not yet been created or are slow in taking shape. The older existing institutions are the army or the police, the courts and the revenue-collecting mechanisms. Developmental institutions for service to agriculture either do not exist, or they are still new and are manned by relatively untrained staffs. When first established such institutions are usually staffed with workers trained in the older services, where the approach is more authoritarian than it is developmental. Workers adequately trained for agricultural development who will work at the "grass-roots" level are scarce.

The overall situation in these countries generally is a wide disorientation of institutions to the needs and tasks of resource development. Contributing to this is the continuing lack of political and

official understanding of development requirements, the general lack of education, effective communications of new ideas, new knowledge and unifying inspiration to the people as a whole.

Obstacles to Water Resource Evaluation

Obstacles to water resource evaluation in West Pakistan, Guinea and Uruguay are physical, economic and institutional ones. They are interrelated with problems of land, of water, and of people, and the interactions among them. Consequently, they are fundamentally associated and inter-twined with the problems of agriculture itself. As agriculture is the basis of the entire economy of these countries a general understanding of the characteristics and the problems of agriculture is basic to evaluating potential resource developments.

The Problems of Agriculture

West Pakistan Whether one considers population counts, contribution to national income, markets for industries, supplies of raw materials, or products for exports, the farmers of West Pakistan are the foundation of her economy.

More than 85 percent of the people live in farm villages; most of the rest have their roots in the soil. In 1960-61, 55 percent of the national income arose from agriculture as against 13 percent from manufacturing, about 1 percent from mining, and 31 percent from government, services, and trade together.¹ The agricultural sector is clearly the

¹Government of Pakistan, Budget 1961-65, Economic Survey and Statistics, April 1960 - March 1961 (Karachi, 1961), Table No. 1.

major market for the other sectors. In 1960, about 96 percent of the output of the manufacturing sector was domestically consumed, mostly by the agricultural sector.²

Agriculture is also the source of most of the foreign exchange. In 1960, with 73 percent of the value of exports whose commodity classes were published came from agriculture, as compared with 27 percent from manufacturing. All of the major manufacturing exports were cotton textile and jute products whose principal raw material comes from the farm.³

In a country of farmers with 35 million acres of cultivated land with inherently good soils, the worlds largest irrigation system, and a climate permissive of year round cropping, food must be imported to provide the meagerest of diets. This unusual combination of rich natural resources could, with the application of modern agricultural technology, produce food and fiber to meet the basic requirements of a population double of that today. Obstacles standing in the way of agricultural improvements and overall economic growth of the country can be summarized under five main headings:

1. High density and rapid growth of population. An estimated 46 million inhabitants, of which only about 12 percent are literate, are attempting to grow their food on 35 million acres of tilled land, about 0.8 acre per person. The cultivated area is increasing by about 1.0

²Computed from data published in J.C. Fei, A Preliminary Input-Output Table for Large-Scale Industries in Pakistan, Pakistan Development Review, Spring, 1962, p. 69.

³Government of Pakistan, Budget 1961-62, op. cit., Tables 23, 24.

percent per year, but the population by about 2.5 percent. With improvements in medical care and public health services, as expected, a growth rate of 3.0 percent is expected in the future.⁴

Agricultural production is lagging population growth; crop yields are among the lowest in the world and have not increased noticeably during the past several decades. The average total production provides food sufficient for only 85 percent of a inadequate and unbalanced diet of less than 2,000 calories per capita per day. Yearly variations in agricultural production range from 10 to 40 percent. The deficit in food, averaging 15 percent of total consumption requirements is made up by subsidized imports, largely from the United States.

Agricultural production would need to be increased 15 percent to feed the additional livestock that are needed to meet the deficiency of animal protein in the present diets. When added to the 15 to 20 percent deficit in the caloric content, it is clear that either the import of food and feed grains would have to be quadrupled or the domestic production increased by at least 30 percent to provide an adequate diet for the present population. Assuming that the present population growth rate of about 2.5 percent will continue, agricultural production must be doubled by 1975 to provide an average daily diet of 2,300 calories per capita.

2. Water Shortage. Irrigation water is required for production of crops on more than 75 percent of the 35 million acres of cultivated

⁴Report of the Food and Agriculture Commission, Government of Pakistan, Ministry of Food and Agriculture, p. 68, November, 1960.

land available to the people of West Pakistan. Rainfall over most of the agricultural areas of the Indus Plains averages about 7.5 inches per year of which only two to five inches are effective for plant growth. Because of the seasonal nature of the river flows, and the shortage of surface storage, nearly half of the water accessible to West Pakistan flows to the sea unused during a short three months of summer. A large fraction of the remainder is lost from the irrigation canals before it reaches the farmers' fields. Variations in river flows, though great in absolute magnitude, are comparatively much smaller than the seasonal variations. An average water supply of less than two feet per acre is available for the presently irrigated land in the Indus Plains, whereas farm deliveries should average more than three feet per acre for a reasonably adequate supply.

Rainfall is concentrated in the three months from July through September. The remainder of the year is exceedingly dry and irrigation is necessary to sustain agricultural production. Summer temperatures are consistently high and the relative humidity is very dry. The loss of water to the atmosphere in the agricultural areas is something like a factor of 3 to 10 greater than the average annual rainfall.

3. Systems of land holding and size of farms. In 1961 there were about 5 million holdings of cultivated land in West Pakistan of which 41 percent were operated by owners and 59 percent by tenants or part-owners. The average size of land holding was only 10 acres of which about 7.5 acres were cultivated. Excluding the holdings of the largest "Zamindors", land holdings for most farmers average only about four acres per farm.

Two types of land tenure systems are prevalent. In the northern portion of the Indus Plains, known as the Punjab, about 80 percent of the land is owner-operated and share-cropping is less prevalent. While large holdings by absentee landlords are common, the typical farm consists of only two or three acres of land. Not only are operating units small but they are often fragmented into several widely separated plots, thus multiplying the difficulties of efficient use of irrigation water, farm animals and equipment, and labor resources.

The typical farmer lives in a mud hut; his other assets include an iron-tipped wooden plow, an oxen or donkey, a few chickens, four or five sheep or goats, a hoe, a rake and a sickle. He often depends on credit at exorbitant rates of interest for most of his production needs, and frequently for subsistence in the months preceding harvest. He must market the small portion of his production available for sale at harvest time when prices are lowest. Crop yields are low due to poor seed, inadequate and untimely tillage and low soil fertility. Because of lack of knowledge of sound water practices, the irrigated land frequently becomes either waterlogged or exceedingly alkaline.

In the southern portion of the Indus Plains, known as the Sind, much of the land is held in large estates owned by absentee landlords, and cultivated by share-croppers. Incomes are so low that improvements in soil and water conservation measures are almost impossible, as the farmers will seldom carry out improvements on land which they do not own, or when they do not share equitably in the returns.

Pressures from bidding for the scarce supply of land are reflected in inequitable rental arrangements, because tenants have little bargaining

power, security of tenure, or incentive for making long-term improvements. The landlord usually pays the taxes for land and water, and takes 50 percent of the crop. Too often he does not bear any share of such costs as seed, fertilizers and land improvements.

Occasionally, land is not cultivated because the owner has little interest in farming, except for prestige of ownership or for investment opportunities for future economic gains.

4. Salinity and waterlogging. Irrigation has been going on in West Pakistan for hundreds of years. As more and more canals were constructed and filled over the years, the water table gradually rose steadily over vast areas until it has come within a few feet of the land surface. The salts left behind by capillary action and evaporation are deposited on the fields and in the soil. This seriously inhibits or prevents plant growth on many hundreds of thousands of acres.

Irrigation practices have also contributed to salt accumulation. Water from the canals is spread so thinly over the land that the average quantity on the fields is less than the potential evapotranspiration during the growing season. None of the irrigation water washes down very far beneath the root zone before it is evaporated, and the residue of salt left by evaporation remains in the upper soil layers.

The amount of land going out of production each year because of becoming salty is increasing at an increasing rate. It is estimated that severe waterlogging and salinity damage in the cultivated lands of West Pakistan is increasing at a rate of 50,000 to 100,000 acres per year. A total of about 6.5 million acres or 22 percent of actually or potentially cultivable lands have been seriously affected by waterlogging and/or high

soil salinity.

5. Primitive methods of cultivation. In West Pakistan we have the wasteful paradox of a great and modern irrigation system pouring waters onto lands cultivated as they were in the days of Abraham, Isaac, and Jacob. Agriculture yields are among the lowest in the world, a situation that is especially disastrous in a country where most of the peoples' income and source of subsistence rests.

Land is plowed by a wooden plow of ancient design with a tiny steel tip, pulled by a pair of bullocks enfeebled by undernourishment. Unselected seeds are sown broadcast, and fertilizers and plant protection measures are seldom used.

Most farmers are conservative and suspicious of proposals by government officials for modernizing agriculture. The margin of production over immediate consumption are too narrow to risk changes to unknown methods and results. They literally cannot afford to take the chance of losing any fraction of their small harvests.

Guinea Lack of national accounts prevents realistic appraisal of the economic structure of Guinea. Most of the statistics offered by the government are unofficial estimates based on fragmentary and often self-contradictory information. However, evidence indicates a deterioration in all segments of the economy since independence from France in 1958. Guinea has been living on loans and technical assistance mostly from Communist Bloc Countries, but with increasing amounts in the last several years from the United States and France.

Economic policies have remained relatively undeveloped in their basic orientation toward a planned economy. A three-year plan for economic

development initiated in 1960 calling for vast ambitious accomplishments has showed little results. Planned projects were not considered in an overall framework with established priorities. Political motivations prevailed in selection of projects and their implementation. The first projects started were a football stadium, national airlines and a hotel. But the old roads and railroads are falling apart and no new ones are being built. French technicians and firms have been made to feel unwelcome and many have left the country.

Power and water failures are becoming more frequent and fuel is often in very short supply. Simple repairs become more difficult, expensive and unsatisfactory. Inferior merchandise is sold in dusty, unkempt state shops and chronic shortages of food and consumer goods are critical. Nails are selling for one Guinean franc each, whether a two-penny brad or a railroad spike. Internal trading has declined since 1958 and banking credits and needed foreign exchange for the few remaining private businesses, mostly large plantations, are difficult to obtain. By all accounts the government apparatus in banking and commerce is grossly inefficient and tending inexorably toward corruption.

Agricultural development in Guineas' planned economy has been neglected. Productivity per man hour is believed to have declined.⁵ Prior to 1959 three quarters of the country's total value of exports were agricultural products. Since that time agricultural commodities accounted for 62 and 40 percent of exports in 1959 and 1960, respectively, but only 32 and 40 percent in 1961 and 1962. Agricultural imports in 1962 amounted

⁵Agricultural Attache, United States Embassy, Conakry, 1963.

to 18 percent of total imports with rice being the most important, amounting to about 53 percent. Imports of rice amounted to approximately 10 percent of domestic production in 1962 and were expected to be increased for 1963. The rate of production of all agricultural products appears to be falling rapidly behind the rate of population growth.

It is estimated that about 95 percent of the people receive their living directly or indirectly from agriculture, largely on a subsistence basis. Only about 120,000 persons are wage earners out of a population estimated at around 3,000,000. The per capita value of the gross national product is estimated at about \$100 but the amount of cash income per year only about \$40.

The problems of Guinean agriculture involves both social and technical issues. The main social issues are largely encompassed by the problems of population growth, health, education, tradition and beliefs, while the technical issues are concerned with problems of shifting cultivation, mixed farming and land tenure.

About 90 percent of the agricultural production is produced by the so-called subsistence sector, either under communal tenure arrangements or by individual operators shifting from plot to plot every few years. Farming techniques are in most cases the most primitive found anywhere in the world and crop yields are very low. The health of the people is extremely poor; the percent of illiteracy is among the highest in the world; drinking water is polluted, malaria is widespread, and dysentery is universal.

The typical farmer lives in a village of mud huts accessible only by a trail. Farm produce and other freight is moved as a head load.

He works the land with a crude hoe, his wife (or wives) and children do most of the tilling and harvesting. The area cultivated is sufficient to provide food for the family and a small amount for sale or trade for bare living necessities. He cultivates his plot of land for several seasons and after the natural fertility is depleted he clears a new plot from the "bush". Association with people outside his village or clan is uncommon. Neither he nor his family can read or write but occasionally news from the outside world is shared by a radio with a more fortunate village member.

On the technical side, the capacity of land to maintain human and animal life is being reduced by soil deterioration and erosion. Agricultural development is inhibited by the traditional system of "shifting cultivation", while backward agricultural techniques, largely responsible for low productivity per man, makes excessive demands on labor resources. But even of greater significance is the fact that the largest sector of agriculture, the so-called subsistence sector, and the people engaged in it contributes very little to the rest of the economy.

Generally, there is no freehold ownership of land. While an individual may have the use of a particular plot of land indefinitely, his rights are limited by members of his clan or tribe. Although there are both social and economic advantages of communal land holding by members of this primitive type society, radical changes are necessary if land over which these rights exist is utilized to give maximum possible sustained yield and to promote better rural living.

As is well known, shifting cultivation is a system under which a piece of land is cleared, cultivated for several years, and then allowed to

revert to bush until it has regained its fertility. A new area is then cleared of brush for cultivation. The resting period for land varies from one year upwards, but usually is between four and eight years. Indefinite continuance of such a system is only possible as long as there is an abundance of land. But with increasing population density, both human and animal, and an expanding demand for agricultural products the resting period of both arable and pastoral lands is being reduced. With each cultivation the humus content of the soil is progressively depleted with the result that the soil gradually loses its organic matter and crumb-structure, and, hence, its capacity to absorb rainfall.

Soil erosion has become a serious problem in Guinea. While notable progress in health is being made through preventive medicine, improved sanitation and veterinary science, these improvements are leading to rapid increases in both human and animal populations. But at the same time soil deterioration accompanied by soil erosion is rapidly reducing the capacity of the land to maintain human and animal life.

Mixed farming, where conditions permit, is probably the best means of maintaining and improving soil fertility and, thus, making permanent cultivation possible. One of the essentials of mixed farming is the keeping of cattle. By replacing hand or hoe cultivation with a plow drawn by animals, the farmer can increase his cultivated area and have a supply of manure which will enable him to obtain better crop yields as well as provide animal products for consumption. Presently, the raising of cattle and cultivation of crops is not compatible. It is customary for farmers to be either a cultivator or a herdsman but not both. The Foulah tribe is notably the herdsman who are nomads. Cattle

are grazed wherever natural forage is available. It is customary to attach prestige and social status stigma to ownership of a large number of animals but little regard is paid to quality or quantity of production. This tends to increase the number of animals relative to available pasture which furthers the deterioration of the soils and promotes conditions conducive to more rapid soil erosion.

Uruguay The economic life of Uruguay is centered on the production, processing and marketing of animal products. About 96 percent of the land area is in farms and three-fourths of it is in pasture, utilized for year round grazing. Much of the agricultural production consists of grain and forage for livestock production.

Uruguay, deficit in minerals and fuels, needs many products from abroad. Attempts are made to pay for these goods by exporting surplus meat, hides and wool. Agricultural exports, averaging 97 percent of total exports in recent years, were valued to \$153 million in 1962. Wool accounts for over 50 percent of total exports, meat and hides for 25 percent, and linseed oil and rice for most of the remainder.

Up until 1950 the value of exports exceeded the value of imports in most years. However, since 1950 the trend reversed and imports have exceeded exports in 9 of the last 14 years. Exceptionally large deficits in trade occurred in 1959, 1960 and 1962.

Present agricultural policies are directed toward increasing farm productivity and exporting more farm products to obtain a favorable balance of payments. Agricultural and livestock production rates are low and have not increased noticeable in the past three or four decades. Consumption rates per capita are increasing due to a growing population

and increased personal incomes, causing a decrease in the volume of products available for exports.

The agricultural development problems, like West Pakistan and Guinea, involve social, economic and technical issues. However, the nature of these problems is entirely different because of differing physical conditions, institutional framework and national environment.

The people of Uruguay originated essentially from European stock. Average income per capita is the highest of any country in Latin America, although wide ranges in income per capita are found. Health standards are high and literacy rate among the highest of any country.

There are a whole series of problems inhibiting agricultural development, the most fundamental of which perhaps are farm management, land tenure, and the government policies and attitudes towards this sector of the economy.

Uruguay has a private ownership system of land tenure with laws and customs favoring the individual. An abundant supply of land together with liberal policies for distribution to private ownership in the country's early history contributed to the creation of large holdings. Original grants of 5,000 acres to each individual were most common. In time, many holdings were consolidated into large "estancias", now ranging up to 500,000 acres each.

In the beginning, the estancia owners hired herders to keep the livestock from straying but as fencing materials become available numerous herders were forced out of work. Many of these herders settled on small tracts of poorer grades of land at the edges of the estancias. This created many small "rancherios" which still exist. Thus, there is

a wide range in the size of ownerships with the numerical majority of the owners controlling a very small portion of the total land area. The advance to land ownership and increases in the average size of operating units for most agricultural workers and small land-owners is blocked by unavailability of land at prices they can afford, inability to secure farm credit at reasonable interest rates, and their lack of desire or ability to assume the responsibilities of ownership.

The typical estancia consists of several thousand acres of land, divided into fenced pastures of about 100 acres each. One herdsman or "peon" is hired to care for the livestock in each pasture. The owner usually lives in Montevideo and visits the estancia on week-ends or whenever it is convenient. He is frequently engaged in political and business activities with but a passive interest in management of the estancia.

It is customary for cattle and sheep to graze the same pastures the year round. Supplemental feeding of hay or grain is uncommon and during prolonged drought and winter periods the animals are subjected to recurring periods of under-feeding and, occasionally, of starvation. It takes from $1\frac{1}{2}$ to 2 years more time to raise beef to slaughter-weight than in most other livestock areas of the world.

The absence of supplemental feeding also contributes to low calf and lamb crops, and high death losses. Calf crops average only 65 percent compared to over 80 percent in the United States. Death losses average 15 percent per year compared to about 5 percent in the United States. High transportation, production, and marketing costs together with low turn-off rates makes the cost of production per unit of output higher than for most other major livestock areas in the world.

The Government maintains a system of subsidies, fixed prices, taxes and differential exchange rates on most agricultural products. In most instances, the relationship between prices and costs are unrealistic. Too often consideration has not been given to the necessity of lowering production costs along with expansion of output. Consequently, many programs have had detrimental effects by (a) increasing production of soil-depleting crops, (b) discouraging diversification of crops, and (c) distorting the pattern of consumption of some products, particularly beef. Prices in the domestic market often are not established in relation to world prices. This has promoted high production costs, encourages smuggling, and places export products through legitimate channels at a disadvantage.

Export and import taxes, levied selectively on agricultural products and production inputs provide most of the income for the Uruguayan Government. For example, wool taxes are 25 percent, and exchange surcharges currently levied range up to 150 percent on imports of fertilizers, tractors, farm equipment and other production inputs. Farmers recognize that they carry the financial burden of the economy, and admit that they cannot expand production under a system of controlled prices and increasing production costs.

Critical Factors Affecting Project Evaluation

As noted, the obstacles to water and land resource development and factors influencing evaluation in these countries are numerous. However, not all are of equal significance to an evaluation of a specific project, nor do all have the same degree of restrictive force

against economic growth and development of the country. Some of the most critical factors affecting the procedure and criteria used in analyzing projects and in understanding the obstacles to agricultural development in these countries are described below.

Government Policies and Goals

The objectives of resource development in one country compared with another frequently conflict. Application of standard procedures or of criteria suitable for one situation is frequently not suitable for the next. For example, the objective of maximizing economic efficiency is not usually compatible with the objective of developing the maximum number of subsistence farms. Nor is it compatible with attainment of Islamic Socialism, a stated goal of the government of Pakistan.

Other conflicts are frequently apparent. For example, the intent of United States Bureau of Reclamation specifications is to classify land for irrigation physically, economically and sociologically. It is generally accepted that such a classification is accomplished by following the rigorous soils standards appearing in the Bureau Manual. Some of the conditions necessary for this classification are those of a modern adequately financed type of agriculture supported by efficient transport, storage, processing and marketing, all within a well-developed economy. Undeveloped countries are inherently disqualified from rigorous classification by these standards since conditions upon which such a classification rest do not exist. Yet these specifications are advocated and, to the extent possible, required by USAID and other international financing agencies for projects in less developed countries.

West Pakistan As stated by President Khan, "the ultimate aim of all

our efforts in economic and social spheres can only be to move speedily towards the attainment of Islamic Socialism in Pakistan. The term Islamic Socialism is almost interchangeable with "welfare state". In addition to the familiar welfare goals, Islamic Socialism implies that the cultural and religious heritage of the country should be preserved and not allowed to be destroyed by the ruthless pursuit of economic development".⁶

The principal agricultural goals are self-sufficiency in the production of food grains for the rapidly growing population and expanded output of agricultural raw materials for the growing needs of domestic industry and for export. Legislation in effect is designed to improve land tenure. This would consolidate scattered holdings, and sub-divide large holdings into family-sized units.

Prices for many farm products are fixed by the government at levels intended to serve as floor prices and to encourage production. The main crops in this scheme are rice and wheat, but the list of commodities for which the government has fixed prices is gradually increasing. The fixed prices for wheat are higher than the official world price and the differential gained from imports to meet deficit domestic needs are used to aid agricultural development programs. Rice is the only commodity on which the government has a monopoly. There are no direct subsidies on acreage or production. Fertilizer is the only farm requisite which receives direct subsidy and the price is fixed at 75 percent of the cost whether

⁶Quoted by President Mohammad Ayub Khan in Outline of the Third Five-Year Plan, Government of Pakistan, August, 1964.

produced locally or imported. However, little fertilizer is now being used in Pakistan.

Guinea In the Guinean plan, the development program in agriculture hinges on the establishment of a cooperative structure with emphases on institutional change.⁷

The new organization includes a first phase of expansion of the present village co-operatives for promotion of improved agricultural methods and collective use of light equipment. A special effort is to be made to release women from long and hard work involved in the home processing of crops in order to allow them more time for home duties and the traditional agriculture.

The second phase will be the creation of collective fields to be exploited by the co-operatives with mechanical equipment. Collective livestock enterprises integrated with field cultivation will be encouraged.

In the third phase, which is to be realized well after the present planning period, all the village fields will be collectively exploited, provided the co-operative members wish to do so.

The Guinean Government maintains complete price control on practically all commodities and imports. Most all production entering internal trade is purchased by the Government and redistributed through state-owned facilities. Wages are arbitrarily fixed and are believed to have little relation to actual productivity levels.

⁷Agricultural Policies of Foreign Governments, Agriculture Handbook No. 132, ERS, United States Department of Agriculture, 1964.

Uruguay The Government of Uruguay is a free democracy with laws favoring free enterprise but with considerable control over major activities for general welfare of the people. The transportation systems are government owned and operated. Education through the University level is free, and the total population is covered by social security. Prices of many commodities for consumption are controlled or subsidized.

Present agricultural policies are directed toward increasing farm productivity for export to enable the country to obtain a more favorable balance of payments. The Government encourages the use of more fertilizer for pasture improvement and better methods of eradicating animal diseases, and provides technical and financial assistance for livestock improvement. The Government promotes the production and consumption of poultry to release more beef for export. In addition, programs of extension, education and supervised credit are being introduced.

Land tenure improvement objectives include expropriating land from large estates for colonization into small farms, and sub-dividing large holdings into family-sized units. Diversification and intensification of cultivation of a variety of crops are being encouraged.

It is clear that the government policies and goals of these countries affect many phases of evaluation procedures and criteria. With the possible exception of Uruguay, economic efficiency goals are secondary to welfare goals. Prices of most farm products are fixed. In many instances, prices of production inputs are controlled, particularly for fertilizers, machinery and seed. Cropping patterns and land use are influenced by such goals as self-sufficiency in production of cereals in West Pakistan, and by emphasis on export products in Uruguay. Other

government policies influencing land ownership, farm size, taxes, wages, etc. are specified which influences the framework and procedures for resource development plans and appraisals.

Lack of Data

Lack of reliable data is undoubtedly the most critical problem faced by investigators in planning and evaluating projects. This problem encompasses all aspects of project development but is particularly crucial for the economic and social evaluations. Seldom are there reliable statistics from which to assess the performance of present resource use or to predict future conditions with project development. Perhaps even more serious are the difficulties to obtain reliable data from detailed field surveys or most other means. Some of the problems of obtaining data encountered while investigating potential projects in each of these countries are described below.

West Pakistan The typical farmer is illiterate and keeps no records of any kind. He can neither remember the exact areas of his fragmented fields, nor their yields. He is suspicious of interviewers and even if he is willing to talk, he is certain to under-estimate his income and over-estimate his expenses. Historically, to do otherwise means to him higher taxes, land rent and water charges to be deducted from his meager income. Studies have showed estimates of crop production from farm surveys as much as 10 to 50 percent lower than actually received.⁸

The farmer pays farm wages in kind which may be the amount of straw

⁸A.G. Asghor and B.A. Asghor, A Study into the Economics of Land and Water Use in Land Reclamation, Pakistan Association for the Advancement of Science, Lahore, March II, 1960.

that the laborer can carry home on his head at the end of the day. Wage rates set by the government frequently are not related to productivity or to actual remuneration received.

The farmers often sow two or more crops together simultaneously, with different harvesting dates and different yields and prices. He cannot provide any reliable details on non-cash costs of production. The amount of irrigation water received is not measured but varies according to location on the ditch and amount of "Bhusa" the irrigator will give the unscrupulous water master.

Produce is harvested and marketed at different rates, in different quantities at different times of the year, and the farmer either cannot or will not give total returns. Much of the produce available for sale is bartered for other goods in terms of quantity of one article for another, established by long tradition. There is no official system of weights and measures, no grading and quality of products bear little relation to price.

Statistics available on population, national income, total agricultural production, volume of internal trade, etc. are not considered accurate. For instance, it is believed that the population is underestimated by several million people because of Moslem tradition of not counting women. Though data are lacking it does not appear that statistics are accurate on consumption levels as computed from production estimates. The figure would indicate that large numbers of people are near starvation, but observation of the health and vigor of the people does not substantiate this.

Guinea The paucity of data on agriculture and the national economy

of Guinea was found to be more severe than in West Pakistan. With the exception of data on foreign trade, there was no official national accounts with which to appraise the performance of the economy. Statistics available on agricultural production, population, income, etc. are unofficial estimates by United States and France government officials.

Field surveys conducted in four areas of lower Guinea revealed that the typical farmer cultivated small plots scattered throughout the "bush" where tillage is possible with his crude tools consisting of an ax, hoe and a sickle. All other implements, containers and home appliances are "home made". He neither knows the size of the area tilled or the quantity of produce obtained. He staggers the planting of crops throughout the year in order to harvest as needed for immediate consumption. His production goal is just enough to fill "the barrel" for food, seed and a little surplus to sell to pay head taxes and buy a little cloth. Production, if any, above these requirements often are not harvested.

The farmer is not usually motivated to increase his cash income, and seemingly is not concerned that fellow countrymen as near as the next village are starving. He uses no fertilizers, insecticides or other inputs that would increase production.

He is suspicious of every stranger but especially the white man, and will divulge no useful information. He resists change from his traditionally oriented environment and lacks incentive or desire to experiment with anything new.

Uruguay With the exception of for the small subsistence farms, statistical data on agriculture and related segments of the economy in Uruguay are good. National accounts and census data are available and

farm records are generally kept by most of the large estancias. The major deficits in data required for project planning and development are related to the quality and quantity of natural resources available, farm management, and to lack of transportation, processing and marketing facilities.

Land Tenure

In any country, no other factor is more important to the existing state of agriculture or to prospects for development than the form of land tenure. A writer for the FAO stated: "The holding and use of land has been of greatest importance for every political and economic system, and indeed is the basis for all social organization."⁹ Tenure systems which are not in accord with economic and social development and lack the capacity for adjustment are considered the greatest obstacles to agrarian reform programs in undeveloped areas.

Problems related to land tenure systems existing in West Pakistan, Guinea and Uruguay are critical obstacles to agricultural development. The tenure system in these countries, being the framework for agricultural production, determines (usually a combination with other factors but sometimes even by itself) the social and economic position of the farmer and his family.

West Pakistan The institution of agricultural tenancy in Pakistan is associated with human exploitation, low cultivation standards and lack of opportunity. In general, semi-feudal economic, social and political

⁹Inter-relationship Between Agrarian Reform and Agricultural Development, FAO Agricultural Studies No. 26, FAO, Rome, Italy, September, 1953.

controls linger as serious obstacles to economic progress and associated agrarian reforms.

About 60 percent of the farmers are share-cropping tenants, operating units averaging about 5 or 6 acres of inadequately irrigated land. The usual crop share to the tenant is half with the farmer providing the family labor, implements, the bullock power and half of the cash costs. Incomes are so low that improvements in soil and water conservation measures are almost impossible as farmers will seldom carry out improvements on land which they do not own, or when they do not share equitably in the returns. In some areas, owners change tenants every few years to prevent any claim by the tenant to ownership rights. The number of tenants competing for the scarce supply of land is large, perpetuating unequitable bargaining power, security of tenure or incentives for making long-term improvements.

Ownership of land in West Pakistan represents a status symbol. Little land is ever sold and its value is high, reflecting scarcity and the social prestige attached to its ownership. Large estates, created under the British famous Zansindar system, are frequently rented to share-croppers. Many of these owners are absentee landlords and have little interest in management, improvements or efficient operation of the land.

Guinea The system of exploitation which arose from the experience of ages is known as shifting cultivation or bush fallow. Land is cleared and cultivated for a number of years consecutively, after which it was permitted to return to a state of bush to recover its fertility. The concept of ownership does not exist, because rights to exclusive use of

land by a specific group are "de facto" not challenged. The amount of land which anyone could work is limited by the manpower of the family and the nature of the tools. The right can be maintained against other members of the group and remains dormant even if the land is temporarily abandoned. Customary laws of succession and inheritance determine whether the land of a member who has died will come back to the community or will go to his heirs.

For all practical purposes, land has no, or a limited, commercial value. Although improvements by clearing, leveling, drainage and diking increase its value for production, they do not represent an increased equity for the cultivator. He cannot sell it or transfer it to other members.

The communal tenure system possesses many advantages but it is not conducive to economic development. Its failure to provide adequate incentive to put effort or money into the land, militates against conservation and improvement. Owing to the limitations to the form of security which it provides, it delays the introduction of permanent cash crops, and, generally, of better farming methods.

This type of land tenure is not well suited to development of individual land and water projects where charges for payment of project costs are expected. Rather than increased benefits from project development there may be no benefits. It is impossible for the farmers to raise loans on the security of the land for purposes designed to increase its productivity even if he preferred an exchange economy. The farmers are oriented to subsistence farming, and so long as other land is available, he will move to other areas rather than pay the costs.

If the agrarian revolution is to proceed without unnecessary impediment and friction, the old customary communal tenures must evolve towards forms of tenure more conducive to economic development.

Uruguay The land tenure system in Uruguay perpetuates use of land extensively for livestock grazing. There is little incentive for owners of large estancias to intensify cultivation by changing land use to cultivation of annual crops or forage. Though returns per unit of land are low, total income to these owners is relatively high.

Summary Statement

Water and land resource development and utilization in these countries are characterized by a great imbalance of production factors. Though only some of the critical obstacles influencing resource developments have been mentioned these are by no means all of them and no one factor can be treated in isolation. Other factors influencing the overall impact of new or improvements in resource on economic growth include transportation facilities, marketing and processing, education and farm management, farm credit, and the whole gamut of elements associated with social and economic infrastructures of each society.

In my personal experience, no issue has been more critical to resource development work than land tenure and other aspects of land reform. This is a burning social and political issue in each of these countries yet the existing systems controlling the uses and ways of holding land differ significantly. But, it has become increasingly clear that the effects that land tenure arrangements have on resource development and use vary considerably according to the economic, social, political and legal institutions. The evaluation processes will vary directly with the

nature of the proposed program, the manner in which it is carried out, the resources of the country and the extent to which existing systems have already been developed.

Crude observation of conditions in these countries indicates that behind the political objectives of land tenure and other land reform measures in these countries is an honest groping for a system which will satisfy two deep and basic needs; (1) much more productive agriculture as a base for national economic development, and (2) a sense of security (and participation) among the peasantry as a basis for needed political stability. Unfortunately these are often inconsistent ends. Too often the so-called "foreign expert" engaged to assist with these problems have furnished too many nostrums and not enough evidence on which to base realistic decisions for the changes that they frequently recommend.

In any event, it is clear that characteristics of rural societies in less developed countries are likely to differ so much from those in developed countries, that experience and methods appropriate to the latter should not be applied uncritically to the former, even though something can be learned from them. More specifically, the measures of agricultural efficiency appropriate to the developed countries are inappropriate to most of the undeveloped countries. As presented in the succeeding chapter, suggested alternative criteria may be more relevant to policy decisions on land reform programs and resource development.

CHAPTER VI

SUGGESTED PROCEDURES AND ALTERNATIVE METHODS FOR PROJECT EVALUATION

The objective of every project evaluation can be stated simply as a comparison of the agricultural situation and production before and after development. The evaluation represents the results of investigations and studies of the physical environment, the economy, and the local population as they individually and collectively affect the development and use of available water and land resources.

If executed properly, the evaluation should indicate the physical, economic and practical feasibility of implementing proposed improvements. Further, it should furnish a sound basis for post-development farm demonstration, training and experimentation. It should also qualify the financial position of the development plan.

There is usually no conflict in the objectives sought in determining the individual and collective effects that the physical environment, the economy and the people have upon resource developments in less developed countries. However, the means of measuring these effects need not or necessarily can not be the same for every project. Experience has shown that obstacles confronting evaluation in these countries can be overcome by adopting procedures and criteria for specific situations, and by developing alternative approaches from which sound judgments can be made without invalidating basic principles of evaluation as outlined by the financing institutions and most resource

development agencies.

Some alternative procedures for obtaining basic data, and for project evaluation are presented in this chapter. Also indicated is the extent and type of data which from my experience is necessary for undertaking a feasibility study in an under-developed country. This represents the minimum data from which reasonably sound decisions can be made in the planning and development stages of a project. Finally, alternative approaches and methods for assessing project effects and individual repayment capacity of project beneficiaries are presented.

Although no two resource projects are completely alike, the evaluation process must cover these four broad subject matter areas:

1. Physical Resources and Agricultural Data
2. Assessment of Benefits and Economic Justification
3. Organization and Management
4. Financing Arrangements

Physical Resources and Agricultural Data

Water Resources

Of the physical resources, water is the first consideration. The appraisal of hydrology is concerned with the quantity, quality and reliability of the water supply. This appraisal is the primary responsibility of the hydrologist but it is of particular concern to the economist who must assess the benefits resulting from a given water supply. To this end, the economist must understand and agree with evidence for supporting the assumptions made in estimating the probable water supply, and be satisfied that water availabilities are conservatively estimated

and that the frequency of water shortages are not excessive.

For instance, in numerous instances hydrological data have been presented on an average annual basis indicating sufficient water for essentially a full supply for the lands selected for irrigation. However, examination of the basic data for water availability has often revealed extreme shortages over several consecutive years of record and for critical months within a growing season. These shortages were of sufficient magnitude to destroy the crops, including perennials, that were assumed for the area. Careful examination of basic data is necessary in project evaluation to prevent "hidden surprises" that are often concealed by average values.

To assist in evaluating the economic significance of available water supplies the following shortage criteria are suggested:

Domestic and Municipal Water Supplies In general, a water shortage at any time in cities having numerous industries could result in a reduction or curtailment of production with severe attendant financial losses. Thus, for project planning, a water shortage for industrial purposes of any magnitude should not be tolerated.

For non-industrial cities, water shortages at very infrequent intervals can usually be tolerated. Though many factors enter into estimating allowable tolerances, planning engineers have frequently set this interval arbitrarily at around 15 years. The economist can assist in establishing optimum shortage tolerance limits after consideration of three factors; (1) opportunities for rationing water for non-essential uses, (2) probable financial losses from shortages and, (3) the savings in capital costs for storage and transmission facilities.

Where stream flow records are not available or if available only for a limited period, which is the usual case in less developed countries, a relatively high storage reserve should be included in project planning as a safety factor. Consideration of projected demands for water, of course, can not be ignored. Evidence from reports on domestic water projects in the United States indicates that a reserve sufficient to supply a minimum of four months draft is necessary.¹ This is an arbitrary estimate which will vary depending on the accessibility and cost of alternative water supplies. Where data are lacking on probable water supplies, a reserve sufficient to supply a minimum of at least six months draft is advisable as a safety factor for project planning purposes.

Irrigation Water Supply Specific mandatory percentage limits for water shortages for irrigation can not be recommended. The analyses must be made on a project to project basis which will determine the optimum amount of land to be irrigated, and the most suitable cropping pattern and intensity of cultivation for the water supply available. For sound project planning, irrigation shortage limits are useful as general guides in establishing the scope of the project. The economic evaluation can proceed and be adjusted, if necessary, in the final planning stage.

Since data are lacking in less developed countries, limits on water shortages can be adopted for project planning from experiences on existing

¹Personal files of Bureau of Reclamation project reports.

projects in the United States. The hypothesis being that these data represent sound project planning and that composite results are adequate for planning and appraisal of similar type projects elsewhere.

The results from study of water supply data for 15 Bureau of Reclamation projects are summarized below.² Column I shows the actual range in water supply shortages for the items indicated for these projects. Column II shows averages for these projects which may be considered as "desirable" limits in project planning which could not be exceeded without serious detriment to project benefits. Column III showing the "general maximum" shortage limits represents averages for the upper quartile. If these shortages are approached on a specific project, major adjustments in crop yields and cropping patterns would be required. In special circumstances these shortage limits may be exceeded in project planning but special care must be made for adequate project design and evaluation.

Though these criteria are arbitrary, they are derived from well engineered projects which provide useful guides for initial planning and evaluation when hydrological data are inadequate or lacking. Adjustments to these general criteria can be made on a project to project basis, if appropriate, to reflect the affects on agricultural production of estimated water shortages as influenced by crop yields, cropping pattern and cropping intensities.

There is no specific problem with appraisal of water quality,

²Obtained from personal files of Bureau of Reclamation project reports on projects in the Western United States.

Tolerances for plant growth for most toxic elements are relatively well defined by plant physiologists. These data are equally applicable to most all project areas.

| <u>Item</u> | <u>Column I</u> | <u>Column II</u> | <u>Column III</u> |
|--|--|--|--|
| | <u>Actual
Range in
Water
Shortages
(Percent)</u> | <u>Average
Shortage
Limits
(Percent)</u> | <u>General
Maximum
Shortage
Limits
(Percent)</u> |
| Maximum water shortage for any single year | 8 to 100 | 51 | 73 |
| Maximum water shortage for 2 consecutive years (total) | 10 to 200 | 68 | 142 |
| Maximum average annual water shortage for 50-year period | 1.0 to 21 | 3 | 6 |
| Maximum in water shortage years (Proportion of years in which some shortages were experienced) | 3 to 38 | 27 | 30 |

Land Resources

In evaluating land resources, it must be established by some means that the project lands are capable of sustained production with irrigation. Such an assurance must be based on adequate climatic, soil, topographic, drainage and agronomic data.

Climate The components of climate are measurable and their effect on plant growth can be determined for any project area by existing scientific techniques. These types of data, provided by plant physiologists and meteorologists, will define natural hazards to plant growth, the

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growing season and the climatical production hazards.

The upper limit of vegetative production which climate will allow may be classified as the climatical potential. It may be expressed in terms of the amount of dry matter produced per unit of time and area. This type of analysis establishes sufficient basis for determining water consumptive use, requirements of plants, and for estimating vegetative productivity under dry-land and irrigated conditions. The analysis of the climatic potential depends upon complete and accurate meteorologic data pertaining to evaporation and rainfall for each month of the year. The components necessary for establishing evaporation rates consist of percent of sunshine, temperature, relative humidity, wind and latitude. The components for establishing the amount of effective rainfall for plant growth are temperature, amount of rainfall and water holding capacity of the soil.

If such data are unavailable or incapable of transfer from a nearby area of known climatic characteristics, using energy balance techniques, special instruments can be set up to record the net solar radiation and the effective evaporation at a particular site.

Soils An inventory of soil characteristics is necessary to aid the selection of appropriate land use, to identify and measure the dimensions of reclamation problems, and to supply the data necessary to classify land for its productive capacity and pedological characteristics.

If sufficient data are not available, the usual case in less developed countries, soil surveys and land classification of some type are required before the project appraisal can proceed. Ordinarily, a land

classification made to semi-detailed standards is desirable. If a choice of type of classification can be recommended, one similar to that developed by the United States Bureau of Reclamation is preferred. This is basically an economic one which determines the potential productive capacity, production requirements, and the land development necessary for sustained irrigated agriculture.

Experience in less developed countries has indicated that frequently a detailed land classification by U. S. Bureau of Reclamation standards is not warranted. Most officials of these countries do not accept such a classification because of being too costly and time consuming and, in general, not considered applicable to existing national environments. The bases upon which these standards are developed include a highly developed economy with good transportation and marketing facilities which do not exist in these countries. Further, the improvement and utilization of land, water, economic and human resources are achieved by vastly different methods.

Often one finds land being cultivated that has been terraced out of a hillside which by U. S. Bureau of Reclamation standards would be classed as non-arable. Because farms are extremely small and labor plentiful many plots have been "built-up" by replacing the top soil. Further, other factors, particularly management, are often more important in influencing total production than differences in soil. Perhaps more often than in the United States an excellent soil is less productive than a poor soil because of poor management. Most frequently these governments do not expect water users to repay all project costs and because the objectives of development are not always profit oriented the arguments

against costly detailed land classification are warranted.

However, consideration of land for irrigation development must accentuate whatever deficiencies of soil or water that exist. Extreme conditions can serve as criteria for the elimination of an area from further consideration for irrigation, drainage or reclamation. Under usual circumstances, any one of the following characteristics can be used to separate unsuitable land from that which is not; (1) slope, (2) soil texture, (3) soil depth, (4) water holding capacity, and (5) soil bulk density. Non-arable or unsuitable lands can be established as those having soil properties unfavorable for economic production of crops, or chemical soil conditions too costly to reclaim. For separation into arable and non-arable, general criteria as developed from the Soil Conservation Handbook, and Bureau of Reclamation Manual are suggested. These data are tabulated below and represent a starting point for land classification in less developed countries which can be adjusted, as required, to reflect local situations.

| <u>Characteristics</u> | <u>Condition</u> | <u>Elimination Criteria</u> |
|--|---|------------------------------|
| Slope ¹ | Sprinkler-Crops | Over 10% |
| Slope ¹ | Sprinkler-Orchards | Over 12% |
| Slope ¹ | Sprinkler-Pasture | Over 20% |
| Slope ¹ | Surface system | Over 10% |
| Soil texture ² | Irrigated | < 7u 5% |
| Soil depth ¹ | < 15% 5u | - 200 cm |
| Soil depth ¹ | < 25% 5u | - 120 cm |
| Soil depth ¹ | > 25% 5u | - 60 cm |
| Soil water holding capacity ¹ | Depth of root penetration | - 10 cm |
| Soil permeability ³ | Irrigated | - 0.1 cm/hr |
| Soil bulk density ³ | Irrigated | + 1.8 |
| Water quality | Baron content | + 1.9 ppm |
| Water quality | Cl + SO ₄ + NCO ₃ | + 25% (Leaching requirement) |

¹Soil Conservation Service Handbook

²Thorne, D.W. and Peterson, H.B., Irrigated Soils, Blakiston Company, 1949.

³Bureau of Reclamation Manual No. V., Land Classification Specifications.

The requirements for evaluating the suitability of soils for irrigation often must be left to the informed judgment of the soil scientist. Extensive and costly surveys can be minimized when the soils are particularly uniform and the project lands are clearly suitable for irrigation. Obviously, if an area to be developed has a history of cultivation by dry-farming or partial irrigation the extent of the survey may be reduced with reasonable assurance of successful production with full irrigation.

Land reclamation costs are estimated partly by economic study, and partly by soil deficiency measurements. The most serious land reclamation problems are usually associated with saline soils. Detrimental salts may be present in land to be irrigated, or it may accumulate from irrigating land without adequate drainage. In these instances, reclamation by leaching and drainage are usually necessary. For most classification, three soil salt conditions are sufficient; namely, saline, saline-alkali and nonsaline-alkali. The limits suggested for these conditions are.³

| <u>Type</u> | <u>Salinity</u>
(EC / 10 ³) | <u>Alkali</u> | |
|------------------|--|---------------|-----------|
| | | <u>ESP</u> | <u>ph</u> |
| Saline | +4 | -10 | -8.6 |
| Saline-Alkali | +4 | +15 | -8.6 |
| Nonsaline-Alkali | -4 | +15 | +8.5 |

These classification limits are useful for separating soils into arable and non-arable categories but do not describe the reclamation potential of an area. This must be done by relating the soils affected by salt to reclamation requirements. For this purpose the following

³Adopted from USDA Handbook 60, Diagnosis and Improvement of Saline and Alkali Soils, United States Government Printing Office, 1954.

prescriptions have proven useful precluding assessment of reclamation costs:

| <u>Condition</u> | <u>Soil Type</u> | <u>Reclamation</u> |
|------------------|-----------------------|--|
| Saline | All | Leaching alone |
| Boron | All | Leaching alone |
| Alkali | Adequate Gypsum | Leaching plus
gypsum or sulphur
amendments |
| Alkali | Calcium-free
soils | Leaching plus
gypsum or calcium
amendments |

Classification of an area for its productive capacity must refer to individual crops. Crops may grow well in some soils and poorly or not at all in others due to soil characteristics. For example, pasture crops produce nearly as well on irrigated soils 50 centimeters deep as they do on deeper profiles. The characteristics that have a direct and reasonably measurable effect on the growth of most crop plants are tabulated below:

| <u>Characteristics</u> | <u>Limitation</u> |
|------------------------|--|
| Depth | Root penetration |
| Texture | The retention and release
of moisture and nutrients |
| Porosity | Aeration |
| Bulk density | Aeration-root penetration |
| pH | Nutrient availability |

The effect of restricted soil profile on crop production is not proportional to reduce soil depth but, according to Storie, follows a curve.⁴ These data are recommended for estimating the effects of these deficiencies on production capacities.

The amount of field work necessary to verify the productive potential and the land reclamation costs will vary for each project, but the

⁴Storie, E., Revised Soil Rating Index, University of California, 1958.

judgment of experienced soil scientists and agronomists must be heavily relied upon. The economist can readily establish the maximum unit reclamation costs that the project can bear when sufficient soil and laboratory data to indicate approximate chemical reclamation requirements are available. With these minimum data, land soil surveys sufficiently adequate for appraisal of potential projects in less developed countries are possible.

Agricultural Data

The objective of project appraisal can be stated simply as a comparison of the agricultural situation and production from the project area before and after development. The investigation necessary to reach this objective satisfactorily are far from simple, and the minimum data necessary for each project are not easily defined.

Generally, land in these countries to be developed is usually under some sort of cultivation so that a considerable array of data is necessary to assess the existing agricultural situations.⁵ Seldom is much of this information available from published sources, and only exceptionally have adequate land use or farm surveys been undertaken.

⁵These include a) land tenure status, including any existing water rights; b) farm size, ownership and operating patterns; c) characteristics and amount of population, including number of farm operators and hired farm laborers; d) prevailing farm practices; e) existing technical and credit services for farmers; f) land use, including rotation systems and cropping patterns; area in current year under various crops and pasture; if already some irrigation, the area irrigated and water usage; g) average crop yields and volume of production, including livestock; h) description and adequacy of farm to market roads and of marketing and processing facilities; i) current prices at farm level for products; j) costs of farm production.

Farm Surveys

With the exception of the large cattle "estancias" in Uruguay, detailed farm schedules used in obtaining farm statistics in these countries proved to be of little value. Most of the data obtained from farmers interviews were biased and unreliable. However, personal interviews did prove useful for obtaining opinions of farmers on probable uses of land and water and the production expected from increases in the water supply.

From experiences with farm surveys in these countries, it was concluded that schedules simply designed were useful for securing opinions and observing problems of most aspects of the farming operations. Though the accuracy of much of the statistical data may be questioned, it forces the investigators into the field whereby they can assess existing conditions and conduct various types of field measurements to obtain first hand information. With this insight into the local situation, more realistic estimates and assumptions for project appraisal can be made.

It is important, however, that the field investigations be made throughout the growing season by experienced technicians in order to observe the full cycle of farm operations and cultural practices. With cooperative effort by the agronomist, the irrigation engineers and the soil scientist, all aspects of the existing agricultural and irrigation problems can be appraised, and realistic projections made of potential conditions with project development.

Land Use Surveys

Reliable information on land use is lacking in these countries. The

collection of statistics is further restricted by lack of maps, aerial photographs, or local location aids.

Under these conditions, a practical method is recommended which will specify the numerous types of land use, as well as kinds of crops produced, and the area occupied by each. The procedure is to employ data taken from straight lines paced at random in the project area. The direction and length of lines taken will depend on the size of the area to be covered, the density of cultivation, and other factors. As many offsets from the base lines as may be required by terrain or convenience can be made.

The hypothesis of this method of determining land use is that the percent of a straight line intersecting a sufficient number of fields growing a single crop is directly proportional to the percent of area represented by that crop. If "field" is defined as any area utilized for a distinct purpose, the land use pattern is measureable.

This method provides a practical and low-cost means of obtaining reliable agricultural statistics for inventory and crop forecasting purposes. It is useful for establishing bases for determining crop yields, livestock numbers, farm sizes, and other useful information. The nature of field work practically eliminates human bias, if performed systematically, and allows use of semi-skilled personnel. Since the method is developed on a statistical basis, false field data can readily be detected. Therefore, field work requires little supervision to insure its accuracy.

An example of land use data obtained by this method during field work in West Pakistan is presented in the following tabulation. In this

example, 53.1 percent of the total area traversed was found to be cultivated and 46.9 percent non-cultivated.

| <u>Land Use</u> | <u>Yards of Line</u> | <u>Percent</u> | |
|----------------------------|----------------------|----------------|-----------------------|
| Millet | 576 | 11.2 | } Food crops
32.3% |
| Beans | 353 | 6.8 | |
| Sugar Cane | 194 | 3.8 | |
| Vegetables | 211 | 4.1 | |
| Sweet Potatoes | 329 | 6.4 | |
| Sesame | 98 | 1.9 | } Oil crops
8.3% |
| Peanuts | 197 | 3.8 | |
| Pasture | 279 | 5.4 | } Forages
15.1% |
| Berseem | 498 | 9.7 | |
| Sub-total | <u>2,735</u> | <u>53.1</u> | |
| <u>Other</u> | | | |
| Brush | 434 | 8.4 | } Other
34.4% |
| Range | 706 | 13.7 | |
| Sand Dunes | 39 | .8 | |
| Waste | 593 | 11.5 | |
| Sub-total | <u>1,772</u> | <u>34.4</u> | |
| <u>Farmstead and Waste</u> | | | |
| Canals and Ditches | 81 | 1.6 | } Cultural
12.5% |
| Villages | 254 | 4.9 | |
| Roads and Trails | 197 | 3.8 | |
| Farmsteads | 115 | 2.2 | |
| Sub-total | <u>647</u> | <u>12.5</u> | |
| Total | 5,154 | 100.0 | |

Farm Product Prices

Obtaining reliable data on prices received at the farm level in less developed countries poses special problems. Statistics on product prices are limited to wholesale or market prices in principal consuming centers or to prices quoted by the government. The government quoted prices frequently are different than the actual market exchange prices. In addition, the market prices represent sales for only a fraction of the crops produced as most of the production is used for food or feed.

If market or government quoted prices are used as the basis for estimating farm prices, the costs of getting the products to market, and the costs for additional processing and distribution must be deducted. This involves estimates of costs for transporting products by camels, donkeys, bull-carts, carrying on a man's back and, in many instances, for taxes and sales commissions at the point of first sale. Further, because of lack of refrigeration facilities, and inadequate transportation facilities the percent of wastage and spoilage is usually very high. Field surveys are the best means of obtaining these types of data. Even though farmers estimates are usually not reliable, realistic estimates of these costs can be made from observation of the marketing operations and from scattered bits of information from local people. Personal opinions of farmers, particularly for estimates of the time involved in marketing a given quantity of products, are useful.

Experience has found it necessary to adjust wholesale or government quoted prices to obtain "harvest prices". Harvest prices represent the average market prices prevailing during the harvesting period. The harvest price in West Pakistan for some products has been as much as 40 percent lower than average yearly wholesale prices.⁶ They are more representative of farm prices because most products are sold immediately after harvesting.

Occasionally, data are sufficient on prices of some products to

⁶An analysis of the Present Agricultural Economy in Selected Irrigated Areas of the Indus Plains, Harza Engineering Company International, September, 1964.

establish price changes over a period of time. A trend in prices is particularly significant for projecting prices over extended periods. It is recommended that when a trend line significance can be established it should be used rather than simple averages. Trend line for prices of cotton, wheat, rice and other staples can often be established since price data on these crops are usually available, at least at the wholesale level.

Farm Costs

There is generally no serious difficulty in obtaining cash costs for agricultural production in less developed countries. Prices paid for seed, equipment, fertilizers, etc. are usually available from government sources or from local merchants. Also, farmers seem to remember expenditures made for production items. However, cash expenditures comprise a very small portion of total costs. It was estimated that not more than 25 percent of total costs on a typical farm in West Pakistan consists of cash expenditures.⁷ The percent of cash expenses for crop production in Guinea was estimated to be even less.

Complicating the determination of reliable cost data for farm production in these countries is the practice of payment for labor in crops. For example, in West Pakistan the barber, laundry man, blacksmith, carpenter, merchant and others providing services or products to the farmers are repaid for their services by a specified amount of cotton, corn, wheat, etc. Also, cattle owners without a feed supply often harvest

⁷Cost of Production of Major Crops, Board of Economic Inquiry, Punjab (Pakistan), 1961-62.

sugarcane for the leaves and tops or harvest grain for the straw. A hired laborer frequently receives all the unthreashed grain he can carry home after a day's work for his wages.

It is almost impossible to determine the amount of man-hours or animal-hours required to produce a crop. In Guinea for example, the practice of communal farming compounds the difficulties in estimating labor utilized in cultivating crops. Most all small subsistence farmers indicate that they are employed "full time" regardless of the size of plot cultivated. Evidence from one study in West Pakistan showed the average farm size sufficient to provide gainful employment to be less than 55 percent of the labor available.⁸ It was found that the best estimate of man-hour requirements for producing specific crops could be obtained by having the farmer estimate the amount of land of a particular crop that he could cultivate if available. Labor requirements could then be imputed.

It is recommended that the cost of family labor be excluded from the total cost of production when calculating net project benefits. The hypothesis is that in view of the large degree of under-employment in these countries, the economic cost of labor is zero or very nearly so. This procedure eliminates the need for estimating labor requirements and for computing the value of family labor income. The cost of hired labor should be included in the analysis of benefits although it may be excluded for calculations of benefits to the economy as a whole

⁸Calculation of Net Agricultural Benefits for the Priority I Areas of Tarbela Reservoir, Harza Engineering Company International (unpublished), 1964.

where there are no alternative opportunities for employment. Also any interest paid by the farmer may be excluded as a production cost if an estimate of the full capital costs for developing and working his land has been included in the project cost estimates.

Projected Agricultural Conditions

Projections of agricultural conditions over the life of a project are dependent upon assumptions about a number of factors that usually now function as constraints on present agricultural production; i.e. shortage of irrigation water, small and fragmented holdings, use of primitive farm technology, inadequate credit, marketing and transportation facilities, etc. Usually, the improvements and changes anticipated are directly related to the agricultural, educational and infrastructural supporting services accompanying the resource development program.

But, in assessing estimates of future crop yields and livestock production, for example, no agriculturalist can possibly be expert on all crops in all countries. Therefore, some reliance must be placed on the views of local technicians and others familiar with crop production techniques within the area. One must examine closely the technical evidence from which estimates have been made and first reach a judgment as to the future yields that should be obtained. He must then adjust this estimate to the level of yields which is judged will be obtained taking into account most of the factors that have been discussed above. The time lag in attaining this level of production must also be assessed in a similar light.

The projection of the crop distribution "with" project condition must recognize the needs of the area, nation and recent trends in

production. It should create a general balance of crops and a rotation that can reasonably be met with the soils, climate, existing farm equipment and the water supply to be made available. As drainage and irrigation water are necessary before full benefits are possible from fertilizers, pest control, improved seeds and other improved practices, the effect on production of the interaction of these inputs in combination is, therefore, extremely essential.

The prospective market for products is often one of the most critical aspects of appraisal. Experience has shown that it is far more often the availability of adequate markets and transportation rather than agronomic factors that sets the limits of intensification of cropping patterns, prices and overall viability of a project. This aspect of the appraisal must justify the forward price projections assumed for the various products and also specify in detail the additional marketing or processing facilities necessary for the attainment of these prices.

A thorough examination is needed for every project to decide whether it can reasonably be expected that the farmers with their previous experience and technical skills will adopt the proposed cropping patterns. The institutional setting of agriculture, its supporting services and previous experiences are important elements entering into this consideration. Obviously, due to the complexity and nature of the judgments involved in both feasibility studies and appraisals, a high degree of professional competence and experience is necessary.

Assessment of Benefits and Economic Justification

As noted, in these countries the data which can reasonably be

expected to be available are seldom adequate enough or reliable enough to warrant any sophisticated economic treatment. In many instances it would be unrealistic to apply more than rather crude tests. However, all resource projects must be proven economically justified by acceptable criteria before financial resources can be secured. Obviously, the economic analysis should reflect use of the best data and techniques available, and only when there are no alternative means available should any procedures be employed that do not permit the most rigorous economic analysis.

Project Investment

Planning personnel are invariably confronted with incomplete data, particularly during the formative period of a resource development project. Judgment and past experience must substitute for costly field investigations which cannot be financed until individual projects have reached priority status. The use of "experience" curves can be extremely valuable in the appraisal stages of a project. However, they should only be used by the people who prepared them, and who know their limitations and applications.

Project Costs There is usually little difficulty in estimating the expenditures to be made during the construction period. However, there are a number of considerations, other than the physical characteristics of a project site, that can materially affect the engineering designs and cost evaluations of a project. These are frequently not given adequate consideration by United States engineers in development of resources in less developed countries. Experience has demonstrated that project cost estimates almost always require some adjustment for economic evaluation.

For instance, the project cost estimates made from the viewpoint of

financing usually include the full cost of equipment which has salvage value on completion of construction. This can be a significant sum, which must be adjusted in the financial and economic analyses.

Conversely, the project cost estimates seldom include supplemental public investments necessary for full development such as improved farm to market roads to transport the increased production. These types of costs must be included in the economic evaluation although they may need not be included in the financial analyses.

Adequate consideration is often not given to changing objectives of design for water control structures. Although engineers try to anticipate future needs, engineering designs and project plans frequently do not permit future extensions, expansions and enlargement of structures. It is a common practice in the United States for engineers to design a project for immediate construction of its ultimate capacity. Experience in less developed countries indicates that more consideration is required for development by stages geared to the pace of the local society. There is a greater need for engineering designs to incorporate flexibility for future use and development.

Experience in the United States has been that costs have continually risen in the past. This is true also in less developed countries and there is no reason to expect otherwise in the future. Two important effects in project planning result from cost escalation that are recognized.

(1) Projects with large initial investments and low operating costs are virtually immune to future rises in costs. These projects have an inherent advantage over alternatives with prolonged investment and high

operating costs. An example of this can be found in the United States in recent refinancing of the Wanapum Project on the Columbia River.

The future annual costs of the Wanapum Project were originally fixed by a 50-year revenue bond issue carrying $4 \frac{7}{8}$ percent interest. Before the project was even completed interest rates had dropped and the project was refinanced at $3 \frac{7}{8}$ percent interest. This reduced the future annual costs by about 10 percent. This project is now immune to increases in either construction costs or interest rates, yet advantage had been taken of a drop in interest rates. Thus, future annual costs of such a project cannot increase, but they could decrease.

(2) Cost escalation also affects resource development planning in the funds required to carry future projects to completion. An estimated cost made at today's price levels for a project to be built 10 years from now tends to be accepted by the government and the financing agencies. These estimates may be qualified with dates and cost indices, but these qualifications are at best "educated" guesses, particularly in less developed countries. It is, therefore, more prudent that cost estimates of future projects be escalated in financial planning as well as economic analyses.

Another effect of time on cost estimating, not related to escalation, is the economic life of civil works. The tendency today is to extend the assumed useful life as necessary to justify a given project. Yet, in many instances, evidence indicates that a shorter life should be considered. The rapid advances in modern technology can make obsolescence a more important factor than the mere duration of concrete and steel. Smaller dams are being submerged by larger dams, under-sized locks are

being replaced, and inefficient power plants are being retired prior to their originally contemplated useful lives. Any project that requires the assumption of an abnormally extended life for its justification should be viewed with suspicion.

Project Labor Costs With respect to local labor, a reduction in project costs is appropriate in certain instances in less developed countries where official wages may be higher than the economic cost of labor. This is, at present, the typical situation in West Pakistan and Guinea.

Both national and local employment conditions should be reflected in the project evaluation. In the case of local unemployment this can be done by increasing benefits by the amount of unutilized or underutilized resources. In the case of national unemployment, it becomes necessary to develop standards to reflect the conditions that exist.

In West Pakistan and Guinea, it is appropriate to reduce project costs by the amount of the labor costs rather than increasing benefits. This resource is otherwise presently unemployed and the opportunity cost is zero. Payments to labor used in construction, for the most part, simply involves a redistribution of income rather than an economic cost. By treating labor costs as increased benefits rather than reduced costs, the benefit-cost ratio of a project is affected in a conservative direction. Despite the questionable reasoning involved, there is undoubtedly some practical basis for this procedure because the estimate of project cost represents the needed requirements for financing loans. For the economic analysis, however, the benefit-cost ratio should represent the economic costs and returns to the nation.

Interest Cost Presently, cost analyses of resource development in less developed countries are clouded by a profusion of assumed and prevailing interest rates. Frequently, interest during construction is calculated on the basis of a rate charged by the central government but this rate seldom reflects the true cost of capital. In some cases where there is a clear difference between the official rate and the "free market rate" the latter would be the most appropriate.

The United States Agency for International Development specifies an interest rate of $3\frac{1}{2}$ percent on the foreign currency component of the project investments, and 6 percent on the local currency component. This procedure further confuses the issue of the proper interest rate.

As introduced in Chapter IV, a procedure to eliminate the need for predetermined interest rates in the economic analyses is recommended. This is to compare a project with alternative investment on a capitalized cost basis. The computation is made to determine the rate of return at which the benefit-cost ratios or cost-cost ratios are 1 to 1. The computed rate of return is then compared with the possible return on alternative investments, and with the general prevailing value of capital.

This procedure eliminates the need for choosing a "proper" interest rate for the evaluation, which will satisfy the requirements of all financing institutions. The results of an example where this approach was used are presented in Figure 4.

The capitalized cost approach is also very useful in comparing a project having a large initial investment with alternative projects having their investments spread over future years. For example, a large hydroelectric project versus a series of smaller thermal plants; or a water

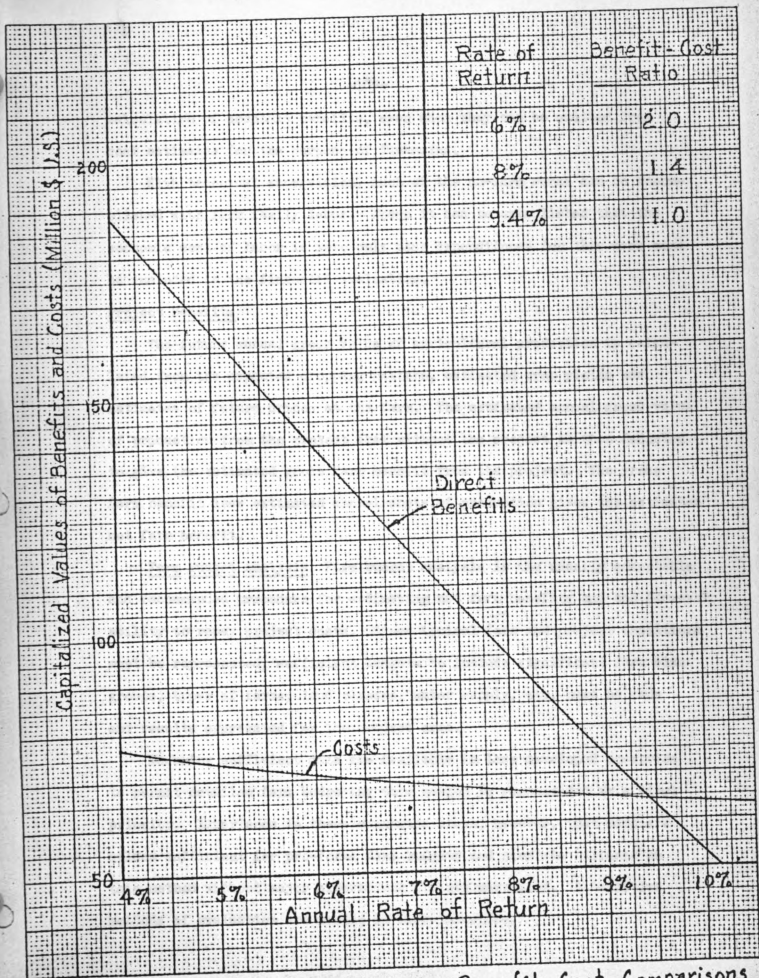
supply reservoir versus a series of groundwater wells.

Frequently, in these cases, a simple comparison of annual costs would favor a large initial investment; whereas, the capitalized cost approach would show greater advantages to deferred investments. However, the application of cost escalation will offset to a considerable extent the relative advantages of deferred investments in a capitalized cost analysis.

The use of both escalation and capitalized costs appears to offer the most realistic and truly comparative values for project analyses. Uniform procedures based on this approach would permit all projects, regardless of the sponsoring agency, to be evaluated for their contribution to the basin and to the regional economy.

A clear distinction must be made between economic value and financial repayment. The requirements for economic return should be just as stringent for a public project as for a non-public project. Actual interest rates to be paid by a particular agency should be considered only in financial analyses.

On-Farm Works Seldom is adequate consideration given to works within farm boundaries such as land leveling, farm ditches and drains, and water control structures necessary to bring the land into production. In most instances it is assumed that construction of these works will be done by the farmers as is done on projects in the United States. Because most farmers lack the technical capability to perform this work efficiently, it should be included as an integral part of the project. If they are to be constructed by the farmers, they must still be investigated in sufficient detail to establish their estimated cost for the



calculation of economic benefits, even when they can be omitted from cost estimates for the purpose of financing.

With technical supervision, much of the on-farm works can be accomplished with farm family labor. Where it can be established that the economic cost of labor is zero, only cash expenditures for this work need be included in the financial evaluation.

Project Benefits

The future annual gross value of agricultural production is calculated from the expected cropping pattern, estimated crop yields and estimates of future prices at the farm. The estimated annual gross value of production from the project area without the project is then deducted to give the estimated gross farm benefit from the project. The gross farm benefit less estimated annual costs of production gives the estimated net farm benefit.

Farm Budget Analysis Farm budget analysis is the usually acceptable and recommended procedure for estimating net farm benefits and the farmers' ability to repay project costs. Since typical farm and project conditions must be represented, sufficient budgets to include significant farm size groups, types of farms, land classes, water supply, etc. must be made and results aggregated for the project area.

Assuming sufficient data are available in less developed countries to permit detailed farm budgeting this method is recommended as a first priority. Experience in these countries shows, however, that data are seldom sufficient for pro-forma farm budgets and complete reliance on this method without major alterations are not warranted. Alternative methods of evaluation are needed in many instances.

Farm budget analysis, as developed in the United States and adopted by most financing agencies for evaluation of projects in less developed countries, assumes that individual farm family operator's net income is the relevant measure of the relative efficiency of farms of different sizes and kinds. Thus, studies in the United States confirm that larger farms normally have correspondingly higher operator incomes leading to the conclusion that they are more "efficient" than small farms. This is true, however, but only with reference to management and labor. They are not necessarily the most efficient in the use of non-human resources. Therefore, although maximum operator's income serves as an adequate criterion in the United States because from a social viewpoint labor is the most scarce factor of production, the situation in West Pakistan and Guinea and similar countries is quite different.

Faced with an imperative need to increase agricultural production, these countries find almost all production factors limiting, except labor. From the public or aggregate social viewpoint, the marginal cost of labor approaches zero. In fact, in the judgment of many leaders it is negative and there would be a positive social value in employing additional labor, even worth sacrificing some production to accomplish. In any event, rural unemployment and underemployment being what they are, and with the certain prospects of even greater pressure of population upon employment opportunities, labor is, from the social standpoint, essentially a non-cost element at any foreseeable levels of increased agricultural productivity.

In direct contrast to the case in highly developed economics, therefore, any measure of relative efficiency of farms of different sizes

must be in terms of returns to non-labor resources to be relevant to problems in West Pakistan, Guinea and similar countries.

Therefore, probably a simple measure of gross value productivity per acre, above variable capital costs, is as relevant to policy decisions under conditions in these countries as net operator-income under United States conditions. This is consistent since observation and study of projects in these countries does not suggest, for example, that the level of productivity is higher on the larger than the smaller farms. In fact, productivity per acre on small subsistence farms is estimated to be higher in most project areas that I have investigated. Therefore, in evaluating projects by farm budgets or other methods, care must be used in calculating gross value productivity per acre to assure that variation in results due to size of farm and other factors reflect returns to the scarce factors of production appropriate for these countries. This is of particular significance from the standpoint of land reform policy, if this is an important aspect of the evaluation.

From experience, it is recommended that every attempt be made to use farm budget method of analysis for evaluation. It has the advantage of providing the most complete analysis for estimating project benefits in addition to providing the basis for conducting the financial feasibility phase of study. If the investigations are sufficiently detailed to enable a budget analysis, the project planners are provided with the most complete information on which to judge all phases of a project.

In instances where the data necessary for detailed budget analysis for a specific area are lacking, the farm budget may be synthesized. That is, the experiences and data from other areas that are similar can

often be used to "build-up" budget data and the results applied unequivocally to the new area. This procedure is satisfactory providing the areas are similar including soils, cropping patterns, farm management, etc. in all respects.

For projects involving supplemental water, a farm budget analysis is particularly difficult when data are lacking on existing water supplies and farming operations. In this case, it may be more appropriate to ignore existing conditions and develop budgets assuming no water without the project and a full supply with the project. Irrigation benefits can then be estimated on the basis of unit values for water and extrapolated to the project area for the amount of water to be supplied by the project. This procedure eliminates the need for extensive survey to establish existing conditions in order to estimate the incremental production anticipated with the project. The main problem is to accurately estimate conditions with the project and to adjust the results so as not to claim benefits accruing to the project lands without the project.

Modified Income To Land In attempting to avoid the perplexing problems associated with the farm budget method analysis, there are numerous instances in less developed countries where estimates of water value are more appropriately computed by a variation of the so-called "income-to-land" method. This method is essentially a computation of the probable amount of the landlords' share of the additional increase in annual crop returns by virtue of the proposed project.

This method must make about the same assumptions as does the farm budget method with regard to the level of agricultural technology, type of farm, cropping patterns and crop yields. Also, it must make

assumptions as to a set of standard rental shares for all crops grown. Experience has found, however, that these data are more readily obtained and with more reliance than most data necessary for detailed budget analysis.

The gross value of water is the increased production from the land which is expected from the application of project water. The net value of water to land is the gross value less increased land costs anticipated with the project. These include; (1) interest on any increased investment in land and farm improvements; (2) interest on the cost of new land development, such as clearing, leveling, and construction of irrigation distribution systems and drainage works, and (3) increased general property taxes on assessments required for roads, schools and other public services.

From the net value of water to land must be deducted increased operation and maintenance costs and a return to management to cover risk and incentive to participate in the project. The value thus computed can be used to estimate the economic feasibility of proposed projects.

Evaluations by this method are particularly useful as aids to project selection and planning. It approaches the problem from the viewpoint of a landlord who has invested capital in land which either has no irrigation water or only a partial supply, and who wishes to know how much more he can afford to invest for additional water. The computed value of water is not an expression of the relative merit of a project because it is possible that a project with a low value might have a high cost-benefit ratio, or vice versa. It has a tremendous advantage over other methods because of less data needed and, in many respects, can

focus solely on incremental changes due to the project.

Crucial to the evaluation by this method are two major factors; (1) estimating changes in property taxes which must be based on a rather complete public finance study of present and potential revenue needs of local governments; (2) estimates of supplemental water needs. In most instances, ditches contain no measuring devices and operators have no idea of water actually applied to each crop. Theoretical consumptive use requirements establishing full irrigation requirements are not always adequate. However, estimates of supplemental water needs on the basis of the number of additional irrigations that would be needed to give lands under each ditch a full water supply after the closing of direct-flow priorities is a practical solution.

Alternative Costs Conceptually, the alternative cost approach can be applied to the determination of benefits derived from irrigation as well as flood control, recreation and power benefits. The relevant alternative cost of rice in Guinea, for example, is the cost of acquiring the rice in the world market. The purchase price or cost to Guinea of a ton of rice would be equal to the value of an additional ton of rice produced domestically in terms of savings in foreign exchange. This sum in essence represents national benefits and for project evaluation would need appropriate adjustment.

This method of evaluation is useful for determining project benefits in specific situations such as a riceland reclamation in Guinea. It can be readily applied with a minimum amount of data to obtain gross national benefits for a special crop but requirements for adjustment to reflect project benefits are not diminished or reduced in complexity.

Land Values In certain instances, comparison of land values with and without irrigation may serve as a useful procedure of estimating primary irrigation benefits. This method assumes that changes "with and without" irrigation reflect a capitalization of expected net income resulting from additional water, allowances made for operation and maintenance costs and water charges.

Advantages of this method are that fewer variables need be estimated than the farm budget method and it involves fewer assumptions and less information. It has the obvious disadvantage of most other methods that the economic value arising from the irrigation water cannot be distinguished from influences of other factors that influence land value. For this reason care must be exercised in its results. Also, in only limited instances in less developed countries is the land market reliable, particularly for comparable land situations for measuring conditions with and without water.

There are instances, however, where sufficient comparability is present or can be modified so that direct measurements can be made. For example, if the project involves an extension of an existing project so that the new lands to be irrigated are quite similar in location, fertility, climate, etc. The procedure is feasible in cases where quick appraisals of potential projects are needed for comparison purposes. It is valuable also as a check upon estimated primary benefits of irrigation investment derived by other methods.

Benefit-Investment Relationships

When the objective of the evaluation is for preliminary appraisal and comparative purposes for initial project planning detailed economic

analysis is frequently not justified. In these instances, benefit-investment ratios, expressed as a percentage may be sufficient.

The first measure of this type is the gross farm benefit-investment in which gross project benefits are set against project investment. This method eliminates the need for cost of production data. Assumptions needed are limited to farm product prices, crop yields, and cropping patterns to obtain gross farm income. Given consistency of method it provides a valuable yardstick for comparison of alternative projects, particularly if agricultural conditions are similar.

Since this measure is primarily of value for comparative purposes, results from many projects provide useful guides for placing a specific project in a relative perspective. Computation of gross farm benefit-investment ratios on 11 projects on which feasibility studies have been completed was as follows:

| Percent | | |
|---------|----|----|
| 103 | 74 | 40 |
| 96 | 50 | 40 |
| 85 | 44 | 40 |
| 80 | 42 | |

The benefit-cost ratios on these projects ranged from 1 to 1 on the projects with gross farm benefit-investment ratios of about 40 percent; and, up to 1 to 3 for the projects with gross farm benefit-investment ratios of 80 to 100 percent. These guides serve to provide rough estimates of the probable feasibility of a potential project.

The second measure of this type is to set the net farm benefit for the project as a whole against the total investment to give the net farm benefit-investment ratio, expressed also as a percentage. Since the

full benefits of the project are seldom obtained until some years after completion of the project, the net benefits must normally be discounted.

Results from existing projects are also useful for providing estimates of the probable feasibility of a specific project. For the 11 projects cited above, the range in net farm benefit-investment ratios, expressed in percent, was 9 to 45 percent. The marginal projects with benefit-cost ratios near 1 to 1 had net farm benefit-investment ratios of about 10 percent; but, about 1 to 3 on projects with net farm benefit-investment ratios of about 45 percent.

Export Parity

In some instances, it may be necessary to adjust net project benefits at the farm level to represent more closely direct benefits to the economy. For example, in Uruguay the major products from potential projects are produced for export. In this instance, the farmers prices are subject to major government intervention, and are set lower than export prices. Total project benefits, therefore, consist of net project benefits to the farmers plus direct national benefits accruing from exports.

Conversely, in situations where domestic production is deficit and considerable imports are made; such as, rice and other products for West Pakistan and Guinea, prices for domestic production are set lower than the world price. The total quantity of domestic production and imports are sold on the consumer market at prices set higher than the prices for imports. Total project benefits, therefore, consist of net project benefits based on controlled prices at the farm level, plus direct national benefits accruing from the imports. This situation parallels the conceptual analysis by alternative costs.

Intangible and Secondary Benefits

The usual explanation of how secondary benefits arise is that unemployed resources will be used or some resources will be utilized more efficiently. Those acquainted with existing conditions in most developing countries generally agree that there are shortages in investment opportunities for both capital and labor resources. Numerous cases may be cited where projects have provided employment opportunities and training, and triggered new demands and interest that have led to genuine economic development. For this reason intangible benefits should be given greater emphasis towards justifying resource development in less developed countries.

Data on which to base a monetary estimate of intangible benefits are not available. In the absence of monetary estimates there should, however, be a discussion of their nature. At least six major types of intangible and secondary benefits of a water resource development should be considered in project evaluation.

(1) The effect of increased food production on the health and welfare of the population, both local and national.

(2) The opportunities of increased investments of labor and capital in the transportation, processing, manufacturing, wholesale and retail of the increased farm production as it moves through all the trade channels from the producer to consumer.

(3) Increased opportunities for the investment of labor and capital in the manufacture, distribution, wholesale and retail of manufactured goods and services moving to the farmers and farm laborers, to satisfy their increased purchasing power.

(4) The benefits of a reduction in the imports of food and the increased export of food and fiber on the national balance of trade.

(5) The increased tax base created by the more productive land and on the increased investments and income resulting from the development throughout the entire economy.

(6) Improved national security and political stability.

Any one of these types of benefits could be justification for projects in less developed countries even though their existence may be questioned in developed countries.

Financial Arrangements

No aspect of project evaluation is more important to the financing agencies or to the borrowing countries than the financial analysis. The number of projects throughout the world that have failed because of inadequate financial arrangements are numerous.

Sufficient funds must be assured for completion of the works and for their operation. Interruption of construction because of shortage of funds can result in economic losses which underdeveloped countries can ill-afford.

Cost estimates must be realistically assessed and ample contingencies allowed to take care of normal risks of inflation, escalation and unforeseen engineering difficulties. Experience has shown that with few exceptions initial costs estimates have been far below actual construction costs.

Firm arrangements are necessary also for provision of all the funds required including both the local and foreign currency components. In

the event there should prove to be an over-run in costs, contracts must provide that any funds necessary to complete the project will be provided promptly as required.

The availability of funds for project operation and the operating accounts of the government agency must be examined during the project appraisal. Generally, estimates of costs of operation and maintenance seldom give much difficulty but problems relating to proposed water charges and other farmer payments toward the cost of the project are extremely complex.

From experience it can be argued that for revenue producing projects the general policy should be that the organizations responsible for such projects earn revenues sufficient to meet all their operating costs plus depreciation, and earn an adequate return on the funds invested. But because of government policies toward agriculture, most irrigation projects are usually not set up on a revenue producing basis. Obviously, the financing arrangements must be more flexible than in the case of a power project. Experience in these countries has proven to me that if no more than as a matter of principle, the farmers should contribute reasonably towards the cost of providing the benefits they receive.

If the project is economically feasible, the benefits should be such that an adequate water charge is within the payment capacity of the beneficiaries. However, in most cases such charges cannot be levied for economic or social and political reasons. In Guinea for example, where land is not privately owned, the peasants are so unaccustomed to cash expenses that a substantial reclamation charge would likely frighten them away from using the project lands with the result of no production

and hence, no economic benefit. It is believed that concessional rates during the first years of operation can be used to solve this problem. The social and political reasons why charges cannot be levied against beneficiaries may be related to the poverty of the peasants but more frequently they relate to government policies of subsidization of agriculture. Important also is the resistance of the agricultural sector to change, where there are long established traditions and rights to water and land.

The financing agencies request repayment analysis of projects as part of the evaluation study. Several methods are suggested for estimating payment capacity or reasonable charges toward meeting project costs.

The farm budget analysis of typical farms is the usually acceptable procedure by financing agencies. The problems with farm budgets have been enumerated.

The next best procedure found to establish water charges was developed for conditions in West Pakistan in which water charges were related to the present net income and adjusted upward proportionately to estimated increased net income with the project. For example, the present net farm income per acre was computed at 200 rupees, and the farmers are now paying an average of 15 rupees per acre for irrigation water or 7.5 percent. With the project, net farm income was increased to 300 rupees per acre. Therefore, farmers could pay the same percent of the increased net income or 22.5 rupees per acre without any added hardship. In this instance, this sum was sufficient to amortize the project costs.

An alternative approach is to assess the farmers on the basis of a reasonable interest rate on the project capital costs for perpetuity. The interest rate may vary but should be sufficient to pay annual costs

of operation and maintenance and provide a surplus for further developments. This procedure is justified by the need for revenue in a nation where agriculture is the major economic activity and where there is a continuing need for additional resource developments.

Water charges assessed against the net income to the landlord may also be on equitable basis for repayment of project costs. This procedure has merit in Uruguay where most land is held by absentee cattlebarons and also in West Pakistan where share-cropping is predominant. Most frequently the net farm income to landlords is higher than to tenants because of inequitable crop-share arrangements, and they, therefore have the highest capacity to repay. Some control measures with this system would likely be required to prevent shift of this cost to tenants in the form of higher rental rates.

Occasionally one finds that a government has set a minimum level of living, usually at a subsistence level. The payment capacity can be estimated, in this case, by using the average per acre net farm income as a base. If, for example, the average net income with the project is 300 rupees per acre and the minimum level of living is 1200 rupees, any farmer with over 4 acres would have income above the established minimum for living which could be assessed for water charges. This is an equitable approach because it would tax farmers with the highest ability to pay.

Organization and Management

Particularly close attention to the proposed organization and management for execution of the project works and for subsequent operation of a project is necessary before the evaluation is complete.

With the exception of Guinea, there is a government authority, such as an Irrigation or Public Works Department, responsible for the planning, execution and operation of projects. The main criterion in assessing the capacity of such organizations is their experience and past performance in undertaking necessary responsibilities. In no case, in these countries were any of the existing organizations capable of carrying out all functions required and employment of consulting engineers were necessary before financing agencies would grant project loans.

The project appraisal must verify that the irrigation or water authority has necessary powers to enter into contracts, acquire rights of way and, in general, to undertake construction and operation. If not, satisfactory legislation must be enacted or, as frequently stipulated by the IBRD, make the passage of such legislation a prior condition for disbursement against the loan.

Not only is there concern with the experience and authority of the government agency immediately responsible for the project, but also with the auxiliary services essential for the proposed agricultural development. It was found that generally agricultural research, farm extension services, farm credit and marketing services are the responsibilities of separate government departments which are not directly related to the organization of the project. Hence, it is more difficult to make specific arrangements for their provisions and frequently one must rely on general undertakings from the government. In the case of Guinea, and West Pakistan, where the government administration of these services is clearly inadequate, special services must be provided directly under a project. In these situations, the project cost estimate should include establishment

of research, extension and credit services, and for the training of staff for these purposes. The success of every project is dependent on the services provided farmers after the project is constructed.

A measure of the probable success of a project in these countries is the willingness of the farmers to participate in the project. One test, of course, is whether the expected farm benefits will be sufficient to cover water charges, land betterment and levies and any other farmer-borne costs of project operation, repay the farmers' own investment for development of his land and leave him with sufficient reward for his additional effort.

Seldom are water laws sufficiently developed to require a majority of farmers within an area to vote in favor of a project before construction can be authorized. Decisions to build a project are almost wholly left to the governments.

In cases where landowners are faced with a substantial private investment for on-farm development it is recommended that operating authorities undertake this work. The slow rate of development if left to landowners is seldom justified. Usually, if land agrarian reform programs accompany the development, the legal charter of the operating authority must provide means to accomplish these measures at the beginning of the development.

It was found from experience that special attention must be paid to legislative and administrative arrangements for new settlement where this is involved in a project. A critical review must first be made of legislation relating to the allocation of land, including proposed conditions of land tenure. The appropriateness of the proposed size of holding for

the condition of farming must be specified. The characteristics and experience of the new settlers must also be considered; for example, nomadic herdsmen such as in Guinea and West Pakistan can not generally be expected to be good cultivators.

The system of selecting settlers should consider experience and suitability for irrigation farming. It is necessary for success of the project that after the settlers have been allocated holdings, it seldom will be within their capacity to develop them fully. With adequate supervision this is usually possible with their own labor. If not, they must command the financial resources required with their own funds, or from adequate credit. Finally, the settlers must be assured of technical guidance to bring farms to full production.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

The demand for economic progress and social improvement in less developed countries has increased steadily in recent years. Major emphasis is given to agricultural improvement programs and to water resource developments as means toward attaining more efficient use of human and natural resources, and higher levels of living. The United States is providing a major share of the technical and financial assistance to develop these resources.

Legal and financial provisions of the international lending agencies require that projects be economically and financially feasible. Feasibility reports submitted to these agencies in support of loans for construction are rated generally as poor. Evaluations of the agricultural, economic and administrative aspects of many projects are frequently inadequate. There are wide variations in the procedures and criteria used by consulting engineers in making the evaluations, and financing agencies to review and appraise feasibility reports.

Since procedures and criteria for project evaluation have not been developed in the less developed countries, the financing agencies and consultants look to the United States for acceptable standards to appraise potential projects. In spite of the high professional level of the methods and procedures used by United States water resource agencies there are

wide variations and inconsistencies which reflect basic differences in concepts, measurement methods and standards, and in comparability of estimates of project benefits and costs.

The obstacles and problems faced by the economist in evaluating water resource projects in less developed countries are generally more numerous and complex than normally encountered in this country. Seldom are there adequate or reliable data with which to properly assess potential projects. There are frequently serious human and institutional problems which complicate evaluation processes. The obstacles faced differ because of differences in the socio-economic conditions among the developing countries which cannot always be overcome with application of uniform stereo-type standards and criteria at every individual project level.

This treatise has attempted to identify the differences in the evaluation procedures and criteria used by major Federal water resource agencies in the United States, and to determine the implications of these differences on the economic feasibility of projects. Consideration is given to the economic logic of project benefits in order to develop a basis for an improved conceptual framework which would be more adaptable to evaluation of projects in less developed countries and, in general, elsewhere.

The principles and concepts of project evaluation were related to specific projects in the three less developed countries of West Pakistan, Guinea and Uruguay. A wide range of differences exists in the physical, institutional and economic conditions of these countries. The range and type of problems encountered are sufficiently broad to give results which have wide implications for project evaluation in most less developed

areas of the world.

The minimum amount and type of data are indicated from which reasonably sound judgments can be made, and from which acceptable principles of project appraisal can be adapted to adverse situations normally encountered in less developed countries. Alternative methods are developed which may be used to obtain reasonable estimates of project benefits where highly developed procedures may not be applicable, and where there are insufficient data for detailed studies.

Conclusions

Current Evaluation Procedures

Procedures for evaluation of water resource projects in West Pakistan, Guinea and Uruguay are in a state of infancy compared with those in this country. Few people responsible for resource development understand basic principles of benefit-cost analysis, cost allocations or other basic concepts of resource evaluation. Decisions to construct projects are frequently justified on the basis of need for additional domestic production of food, or because of political promises to do something for a particular area. Since loaning agencies require high standards of evaluation for projects they finance, procedures developed in the United States are used for evaluating potential projects in less developed countries.

Evaluation techniques used by Federal water resource agencies in the United States vary significantly, and, in many instances, do not conform to procedures recommended by Senate Policy Committees. Basic differences exist in concepts, measurement methods and standards, and in the comparability of benefits and cost estimates. The fate of a particular

project may be determined by use of techniques acceptable to one agency but not another. The divergencies are due mainly to differences in assumptions regarding secondary benefits, interest rates, prices, salvage values, taxes and time periods. Benefit-cost ratios computed by techniques of different agencies for the same project would not be comparable nor would they mean the same thing.

Differences in the financing terms among the various financing agencies are also considerable. A particular project may be financially feasible under terms of one agency but not another. The various financing agencies were established for specific purposes, and their spheres of activity tend to supplement and complement each other. However, it is possible for a particular project to qualify for financing from several agencies. Seldom do the project investigators know the source of financing prior to conducting feasibility studies. This is one source of much of the variation in feasibility studies of projects in less developed countries.

It was concluded that if benefit-cost analysis is to provide meaningful comparative guides for decision making, uniform standards and techniques must be applied by both the project investigators and the financing institutions. Uniform standards across all projects and functions may not always be practical but would greatly facilitate comparisons between projects and between alternative public investments.

Economic Concepts For Project Evaluation

The presently acceptable format for economic analysis of water resource projects is the benefit-cost analysis. But if the sole criterion for project evaluation is "if the benefits to whomsoever they accrue

exceed the estimated costs" there can be several interpretation of the manner in which the overall criterion for project justification can be applied in addition to the conventional benefit-cost ratio.

If water resource investments are not restrained by capital rationing, the choice between alternative criteria becomes an academic question. Application of other criteria, including rate of return, can satisfy the legal requirement that benefits exceed costs. If it is desirable to rank projects such that they will be undertaken in optimal order, the net benefit criterion is unsatisfactory since it gives no consideration to costs. Ranking by the rate of return criterion ensures that the present value of available resources is maximized. The project with the highest rate of return on invested capital would be placed first in the ordering.

The straight-forward rate of return method (where the discount rate which equates the present value of net benefits to capital costs) has the advantage that the computed return is the maximum interest rate which leaves the project barely justified. Results from this method will satisfy requirements of the international financing agencies because regardless of the interest rate charged, or if rates change, no additional calculations are required to bring the analysis up to date.

Benefits of water resource projects can be defined conceptually in terms of consumer surplus. The alternative cost approach is a reasonable approximation of gain in consumer surplus and, therefore, is a recommended method for evaluation of most project benefits.

If net secondary benefits from a project do exist, they should be evaluated as carefully and precisely as primary benefits. However, the

manner in which secondary benefits are included in the calculations can lead to different results. The logical procedure is to add the additional benefits and costs to primary benefits and costs, respectively, before calculating the ratio.

Under conditions of full employment it is not known how inefficiently employed resources are distributed throughout the economy, if in fact such a situation exists. Consequently, in this situation it is recommended that secondary benefits not be included in the evaluation to determine whether or not a project should be built. The question of chronic unemployed resources in less developed countries is somewhat clearer. Underemployment of resources is persistent, and food shortages and low levels of living are the usual case. Hence, it is contended that water resource projects in these countries have maximum beneficial influences on economic development. Greater consideration to secondary benefits is warranted and should be included in project evaluations. Government subsidization of economically feasible resource projects which are not financially feasible because of incapacities of subsistence type agriculture and inability of peasant farmers to assume responsibility for reimbursement of project costs is justified.

It was concluded that projects should be evaluated at the current interest rate, because this rate is the best indicator of the value of resources for alternative investment. Past levels and structures of interest rates reflect past conditions and guesses about the future, and cannot be superior in any way to information in current rates. The question is to determine the correct current interest, or preferably, the schedule of rates to be used. Ideally, the schedule of rates should

be chosen that best reflects the risk consistent with water resource projects. Consequently, it is recommended that no rate less than AAA corporate bonds be used because they represent the minimum risk in the private investment sector, and are very unlikely to overstate the risk involved.

For project evaluation, it was concluded that the most reasonable assumption on price levels is that the future level will be the same as the current one. The current interest rate is chosen since it best reflects intertemporal values at the time resources are committed. Likewise, the price of capital goods must reflect the value of those goods at the time they are used for the project. Consideration must be given to current abnormalities in the price structure, and speculate to some extent about the forces influencing price behavior in the long run.

The conclusion was reached that current prices are our best point estimate for the future because of lack of tools with which to predict with conviction. The problem of what is "current" is compounded in less developed countries because of influences of extreme seasonal and short-run price fluctuations and manipulation by governments. In some instances world prices would be more appropriate for project evaluation. Adjustments to prices used should reflect marketing conditions, government policies, and other situations.

Obstacles To Evaluation and Resource Development

Obstacles to water resource evaluation in West Pakistan, Guinea and Uruguay are physical, economic and institutional ones. They are interrelated with problems of land, of water, and of people, and the interactions among them. Consequently, they are fundamentally associated and

inter-twined with the problems of agriculture itself; including, high man-land ratios and rapid growth of population, water shortage, systems of land holding and size of farms, primitive methods of cultivation, lack of marketing and transportation facilities.

The obstacles to water and land resource development and problems of evaluation are not of equal significance to a particular country or a specific project. Individual project evaluation must be complemented by coordinated investigations of public welfare aspects of a project from regional and national perspectives. The problems encountered reflect, not simply affect its business structure and practices, government mechanisms and policies, the encrusted situations and practices in agriculture, and the religious beliefs, education, history, culture and traditions of the people.

The three most critical obstacles to resource evaluation in these countries were; (1) government policies and goals, (2) lack of data, and (3) land tenure arrangements.

The objective of maximizing economic efficiency, inherent in U. S. evaluation standards, is not compatible with government policies in some countries, for example, of developing the maximum number of subsistence farms. Nor is it compatible with the attainment of Islami Socialism, a stated goal of the government of Pakistan, or the primitive communal farming in Guinea. Economic efficiency goals are secondary to welfare goals. Further, such standards as specified by the U. S. Bureau of Reclamation for land classification as required by financing agencies are not applicable since conditions upon which such a classification rest do not exist.

Lack of data is undoubtedly the most critical problem faced by investigators in these countries. The major deficits in data required for project planning and development are related to the quality and quantity of natural resources available, farm management, production costs, and lack of transportation, processing and marketing facilities.

No other factor is more important to the existing state of agriculture or to prospects for development than the form of land tenure. Tenure systems are seldom in accord with economic and social development. This is a burning social and political issue in each of these countries yet the existing systems controlling the uses and ways of holding land differ significantly.

It was concluded that characteristics of rural societies in less developed countries are likely to differ so much from those in developed countries, that experiences and methods appropriate to the latter should not be applied uncritically to the former, even though something can be learned from them. More specifically, the measures of efficiency appropriate to the developed countries are inappropriate to most of the undeveloped countries.

Minimum Data Requirements and Alternative Procedures

Many of the obstacles confronting project evaluation in less developed countries can be overcome with alternative or modified methods and standards. Alternative evaluation procedures can be developed from which sound judgments can be made without seriously invalidating the basic principles outlined by the financing and development agencies. However, for every project study there is a minimum amount and type of data required to assess the potential performance of a project from four major

aspects; (1) the physical resources and agricultural situation, (2) the assessment of benefits and economic justification, (3) project organizing and management, and (4) project financing.

Water shortage criteria developed from experiences on existing, and presumably well-engineered projects, are useful for evaluation of potential projects where data on water supply are essentially lacking. Similarly, land classification criteria based on extreme soil deficiency limits can be adopted which provide reasonable assurance of the feasibility of lands for reclamation and irrigation. Soil deficiency factors under conditions of subsistence farming, poor management, etc. are of lesser significance in predicting potential productivity of soils in less developed countries. Application of U. S. Bureau of Reclamation land classification standards are frequently not appropriate since conditions under which they were developed do not exist in the peasant economies.

Data obtained from farm surveys and personal interviews are usually biased and unreliable. The primary advantage for farm surveys is to observe at first hand the existing agricultural situation from which reasonable estimates by experienced technicians can be made. This requires observation throughout the production cycle in order to adequately estimate all phases of the farming operations. Land use data can be estimated by linear measurements from straight lines placed at random in a project area.

Data on farm prices are seldom available. Retail and wholesale prices are usually available but most frequently require adjusting to reflect local conditions, time of marketing, and costs of getting produce to the markets. It is recommended that the costs for family labor be

excluded from the total cost of production when calculating net project benefits because the economic cost of labor in these countries is very low.

The cost of hired labor should be included in the analysis of project benefits but excluded for calculation of benefits to the economy as a whole where there are no alternative opportunities for employment.

Project cost estimates by engineers almost always require some adjustment for economic evaluation. Items of costs that are most often excluded are estimates of the value for equipment, and supplemental public investments for full development such as farm to market roads. Adequate consideration is often not given to changing objectives of design for water control structures nor to development by stages geared to the pace of the local society.

In many instances it is more appropriate to reduce the project investment by the amount of the labor costs since labor is otherwise unemployed or underemployed and its opportunity cost is zero. Payments to labor for construction simply involve a redistribution of income rather than an economic cost.

Project benefits can be estimated in numerous ways. The farm budget analysis is recommended but in certain situations reasonable approximations of benefits are possible by modified methods of income to land, alternative costs, capitalized land values, benefit-investment relationships, export parity and other methods. To eliminate the need for predetermined interest rates, it is recommended that alternative investments be compared on a capitalized benefit-cost basis. This approach will determine the rate of return at which the benefit-cost ratios or cost-cost ratios are 1 to 1.

It is recommended that intangible benefits be given greater emphasis towards justifying resource projects in less developed countries. Projects provide additional employment opportunities, training, and triggers new demands and interests that lead to genuine economic development.

The number of projects throughout the world that have failed after construction are numerous because of inadequate financing arrangements and provisions for project operation and maintenance. Problems relating to proposed water charges and other payments by farmers toward the cost of the project are extremely complex. Peasants are so unaccustomed to cash expenses that substantial charges would frighten them away from using project lands with the result of no production and, hence no economic benefit. The basis for payment charges can be established in numerous ways related to estimated increased net income. As a matter of principle farmers should contribute reasonably towards the cost of providing the benefits they receive though subsidization of project costs is justified in most less developed countries.

Project appraisal in less developed countries requires greater concern for the proposed organization and management of the project works. It is recommended that government agencies take a greater role in decisions to build and operate projects as well as undertaking on-farm development works, and other functions normally performed by individual farmers in this country.

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APPENDIX

AGENCIES WHICH HELP FINANCE FOREIGN TRADE AND INVESTMENT

(Prepared in the Bureau of International Programs, Department of Commerce)

| | EXPORT-IMPORT BANK | AGENCY FOR INTERNATIONAL DEVELOPMENT (AID) | | INTERNATIONAL MONETARY FUND (IMF) | INTERNATIONAL BANK (IBRD) | INTERNATIONAL FINANCE CORP. (IFC) | INTERNATIONAL DEVELOPMENT ASSOCIATION (IDA) | INTER-AMERICAN DEVELOPMENT BANK (IDB) | INTER-AMERICAN SOCIAL PROGRESS TRUST FUND | |
|--|---|--|--|--|---|---|--|---|--|--|
| | U. S. Dollars | U. S. Dollars ¹ | Foreign Currencies; Special Loans | Investment Guarantees | Currencies of Member Countries | Currencies of Member Countries | Dollars | Currencies of Member Countries | Currencies of Members (Principally Dollars) | IDB Administered Trust Fund—Dollars |
| Purpose | Aid in financing, and facilitate U. S. foreign trade. | Assist in developing economic resources and productive capabilities of less-developed countries and increase economic cooperation, trade and private investment. | Assist in development of less developed countries and expand markets for U. S. agricultural products. | Encourage, facilitate and increase the participation of private enterprise in furthering the economic and social development of the less-developed countries. | Promote international monetary cooperation and encourage stability by providing resources to meet short-term balance of payments problems and by providing resources to member countries. | Aid the development of productive facilities and resources in member countries. | Further economic development by encouraging growth of productive private enterprise in less-developed member countries. | Promote economic development in member countries by providing finance on terms not possible under IBRD, of which IDA is an affiliate. | Contribute to accelerating process of economic development in member countries. | Provide capital and technical assistance to support efforts of Latin American countries to achieve greater social progress and balanced economic growth. |
| Resources | \$7 billion of which \$1 billion capital stock subscribed by U. S. Treasury; \$6 billion borrowing authority. | Annual appropriations of \$1.1 billion for FY 1962 supplemented by long term commitment authority (\$7.2 billion for FY 1962-1966). | Up to 25% of proceeds of sale of U. S. surplus agricultural commodities in each country. | Annual appropriation. Currently \$1 billion for specific risks and \$10 million for pilot housing in Latin America. | Resources out of gold and holding of member countries' currencies. \$14.6 billion. The U. S. quota is \$4.125 billion. | Capital subscription of member countries: \$20.4 billion of which approximately \$2 billion in and \$18 billion callable. U. S. subscription is \$6.33 billion of which \$5.7 billion is callable, if required by the Bank to meet its obligations. | Capital subscription of member countries of \$90.4 million, and proceeds of sale of investments. | Proposed initial subscription of \$1 billion, of which \$910 million subscribed. U. S. subscription is \$162.3 million. Review of resources required every five years with a view to replenishment. | Authorized resources of \$200 million of which \$150 million is for "Ordinary Operations" and \$150 million is for "Fund for Special Operations". \$11.6 million of callable capital to meet defaults on Bank's securities of which U. S. share is \$200 million. ² | \$394 million appropriated by the U. S. |
| Nature of Loans | 1. Project loans.
2. Exporter credits.
3. Medium-term comprehensive guarantees or insurance.
4. Short-term comprehensive insurance. | 1. Loans to foreign governments.
2. Loans to private U. S. and foreign firms.
3. Loans to intermediate financing institutions. | 1. Loans to U. S. firms, their subsidiaries and affiliates abroad for business development and trade expansion.
2. To U. S. or foreign firms to expand foreign markets for U. S. agricultural products. | Guaranteed investments include equity, loans, licensing arrangements, contributions in kind or any combination of these. | Member's purchases from IMF of currencies of other members for an equivalent amount of the member's own currency. A member's purchase from the IMF is currently a purchase by the U. S. at par. | Loans to member governments to other public or private entities if guaranteed by a member government. | Investment in productive private enterprises. May now subscribe to their capital stock. Guarantees of member governments not sought. | Credits to member governments or territories. | Loans to member governments or political subdivisions of such members and to public and private entities in those countries from the Bank's resources for "Ordinary" and "Special" operations. | Loans in fields of land settlement and use, low income housing, community water and sanitation and, to a limited extent, higher education. |
| Who Can Apply | 1. U. S. or foreign firm, or friendly foreign government.
2. U. S. exporter.
3. U. S. banks; or export directly until cover becomes available at Foreign Credit Insurance Association (FCIA).
4. U. S. exporter at FCIA. | 1. Foreign governments.
2. U. S. firms and firms in recipient countries.
3. Development banks, savings and loan associations and other lending institutions. | 1. U. S. firms only.
2. U. S. and local firms. | U. S. citizens and firms. U. S.-chartered corporations "substantially, beneficially owned by U. S. citizens" and their wholly-owned subsidiaries on investment in friendly less-developed countries with which the U. S. has an over-all guaranty agreement. | Member governments. | Member governments, public and private entities guaranteed by member government. | Private firms operating in less developed member countries on projects which contribute to the development of the private sector, offer promise of return, and for which adequate financing from private sources is not available on reasonable terms. | Member countries, and their territories. | Member governments, their agencies and subdivisions; public or local firms (or owned jointly by local interests); public or private re-lending agencies. | Governments, public institutions, private borrowers and cooperatives. |
| Guarantees | 1. May guarantee payments of project loan financed by private sources.
2. Not applicable.
3. Up to 85% of credit and political risks.
4. Up to 85% of political risk; up to 95% of political risk. | Not applicable. | Not applicable. | 1. Guarantee of new investment against specific risks (expropriation, inconvertibility, loss due to war, revolution or insurrection).
2. All risk guarantees.
3. Guarantees of investment in private pilot or demonstration housing projects in Latin America. | Not applicable. | Full or partial guarantee of loans by private lenders for purposes noted above. If such loans are guaranteed by a member government, Guarantee authority has not been exercised. | Not applicable. | Not applicable. | May guarantee in whole or in part loans by private investors. Guarantee Authority has not been exercised. | Discretionary. |
| Maturity | 1. Eight to more than 20 years according to nature of project.
2. One to 5 years (exceptionally 7 years).
3. One to 5 years (exceptionally 7 years).
4. Up to 180 days. Special cases up to 1 year. | 1. In general up to 10 years, including ten-year grace period, in special situations, substantially shorter terms.
2. Flexible; grace periods in some cases; economies of project a major consideration.
3. Flexible to permit revolving credits, including grace periods in some instances. | Based on nature of project but generally not exceeding 10 years. | Normally up to 20 years. | Members undertake to repurchase within a period not exceeding 3 to 5 years. | Generally 15-35 years. | Generally 5 to 15 years. | All credits so far extended for 50 years, with 10 years grace period and graduated amortization. | 1. 10-20 years in "Ordinary operations".
2. 10-50 years in "Special operations". | Generally 15 to 30 years. |
| Current Interest Rates or Fees | 1. Minimum interest 5%.
2. Minimum interest 6%.
3. Fees vary by market and term of credit.
4. Fees vary by market and term of credit. | 1. Generally 3 1/4 to 4 percent, but may vary under special circumstances.
2. Based on nature of project, generally 3 1/4 percent.
3. Based on local rates and nature of sub-loan. | 1. Based on local rates and nature of project.
2. Based on local rates and nature of project. | 1. Current rate is 3 1/2 to 4 percent on liability for each risk actively covered; on "stand-by" coverage, 3 1/2 to 4 percent.
2. Under consideration, probably 2 1/2 to 3 percent.
3. Same as above. | Service charge of 1/4 of 1%, plus fee on purchases in excess of \$100,000. With the full time purchase outstanding and amount purchased, interest rate is 2 1/2 percent annum. | 3 1/2% currently—based on cost of money to Bank, plus 1% commercial and 3/4% for administrative expenses. | Currently about 7% for loans. No fixed interest on equity participation. | 3 1/2 to 1% service charge; no interest. | 1. Currently 3 1/4% for "Ordinary Operations".
2. For "Special Operations", about 4% repayable in currency of borrower, higher in certain cases where funds are for lending. | Generally 1 1/4% to 2 1/4% payable in local currency plus a 3/4 of 1% per annum service charge, payable in dollars. |
| Currency of Repayment | U. S. dollar. | U. S. Dollars ¹ | Foreign currency loaned. | Not applicable. | Gold or convertible currencies. | Currency loaned. | Currencies loaned—usually U. S. dollars. | Currency loaned or other foreign exchange as appropriate. Has power to accept local currency but no indication power will be used. | 1. For "Ordinary Operations" in currency lent.
2. For "Special Operations", in whole or in part, in currency of borrower. | Largely in the currency of the borrowing country. |
| Where Proceeds Must Be Spent | In the United States. | Primary emphasis on U. S. procurement. | Locally. | Not applicable. | Not limited to U. S. procurement. | Not limited to U. S. procurement. | Not limited to U. S. procurement. | Not limited to U. S. procurement. | Cooperates with other sources of financing. Takes into account the ability of borrower to obtain private loans on terms which the Bank considers reasonable. | Limited to procurement in U. S. and member countries. |
| Relationship to Other Sources of Financing | Does not compete with private capital. | Must take into account whether financing obtainable on reasonable terms from free world sources. | None. | Not applicable. | Cooperates with and acts through member countries, through central banks, stabilization funds, or similar local agencies. | Cannot lend where private capital is available on reasonable terms. | Cannot lend where sufficient private capital is available on reasonable terms. | Cannot lend when private capital is available on reasonable terms. | Cooperates with other sources of financing. Takes into account the ability of borrower to obtain private loans on terms which the Bank considers reasonable. | Must take into account whether assistance can be obtained from national or international agencies or private sources on reasonable terms. |
| Decision Making Body | Board of Directors with advice of National Advisory Council on Int'l. Monetary and Fin. Problems (NAC). | Administrator of AID with advice of NAC. | Administrator of AID with advice of NAC. | Administrator of AID with advice of NAC. | Board of Governors, or, as delegated, the Board of Directors, U. S. Director instructed by NAC. | Board of Governors, or, as delegated, the Board of Directors, U. S. Director instructed by NAC. | Board of Governors, or, as delegated, the Board of Directors, U. S. Director instructed by NAC. | Board of Governors, or, as delegated, the Board of Directors, U. S. Director instructed by NAC. | Agreement establishing the Inter-American Development Bank and the IDB Act (PL 86-487). | The Social Progress Trust Fund Agreement, and Act authorizing Inter-American Social and Economic Association. |
| Legal Authority | Export-Import Bank Act of 1945, as amended. | Act for International Development of 1961, Section 201. | PL 480, Sections 104(a) and 480. | Act for International Development of 1961, Sections 221-224. | Articles of Agreement and Bretton Woods Agreement Act. | Articles of Agreement and Bretton Woods Agreement Act. | Articles of Agreement and International Finance Corporation Act. | Articles of Agreement and International Development Association Act. | | |

¹On the basis of current membership. Authorized resources originally contemplated \$1 billion which was reduced to \$928.5 million when Cuba did not become a member (1/1/61).

²Excludes \$100 million authorized by AID for grants and for loans for health and education; and \$6

million to the Organization for American States for technical assistance in public administration and other fields.

³Agreement signed on June 19, 1961 between the U. S. and IDB.

⁴AID also extends grant assistance for development and support of economic. In some circumstances, Supporting Assistance may take the form of local currency repayable loans.

IMF's contribution to economic development efforts, while important, is indirect rather than direct.

APPENDIX TABLE 2

BENEFIT-COST RATIOS ON CORPS OF ENGINEERS PROJECTS

| <u>Item and Location</u> | <u>Benefit-Cost Ratio</u> |
|--|---------------------------|
| Demopolis Dam & Lock, Tombigbee River,
Ala. | 1.07 |
| Jim Woodruff Dam Apalachicola River,
Fla. | 1.12 |
| Buford Dam, Chattahoochee River, Ga. | 1.12 |
| Chain of Rocks Canal, Missouri River,
Ill. | 2.0 |
| Lock 19, Mississippi River at Keokuk,
Iowa | 1.4 |
| St. Anthony Falls, Mississippi River,
Minneapolis, Minn. | 1.4 |
| McNary Dam & Lock, Columbia River | 1.19 |
| The Dalles Dam, Columbia River | 1.26 |
| Reconstruction locks #2, Monongahela
River, Pa., and W. Va. | 3.17 |
| Cheatham Dam & Lock, Cumberland River
Tenn. | 1.77 |
| Old Hickory Dam & Lock, Cumberland
River, Tenn. | 1.55 |
| Gulf Intracoastal Waterway, Colorado
River locks | 1.5 |
| Chief Joseph Dam, Columbia River | 1.59 |
| Ice Harbor Dam & Lock, Snake River | 1.19 |
| Howell Mill Shoals Dam, Coosa River,
Ala. | 1.19 |
| Upper Columbia Dam & Lock, Chattahoochee
River, Ga. | 1.12 |
| Warrior Dam & Lock, Warrior River, Ala. | 1.27 |
| Celina Dam, Cumberland River, Ky. | 1.25 |
| Fernbank Dam & Lock, Ohio River | 1.36 |
| Greenup Dam & Lock, Ohio River | 1.33 |
| New Cumberland Dam & Lock, Ohio | 1.18 |
| Carthage Dam, Cumberland River | 1.52 |
| McGee Bend Dam, Angelina River, Tex. | 1.41 |
| Hildebrand Dam & Lock, Monongahela River | 1.72 |

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