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PART I

THE PANAGUA PROJECT REPORT

(A Summary Version)

I. INTRODUCTION

The Panagua Project is proposed by the Ministry of Irrigation of the mythical country of Galivia as part of a broad scheme for the development of water resources in the Western region of the country. This region is characterized by an extreme dependence upon relatively primitive agricultural activities, with a minimum of industrial development. One of the principal obstacles to the economic and social development of the region is the irregular distribution of water. Rainfall in most areas is inadequate for profitable cultivation. However, the water resource potential of the rivers in the region is sufficient to irrigate a substantial portion of the dry land.

The Panagua Project itself is located in the province of Mendalva. It is designed to direct water from the Rio Casqueva to irrigate an area of 40,000 hectares in the Secotuan Valley. The predominant climate in this valley is hot and dry, and the vegetation is typical of arid zones. Due to the lack of water, there is currently very little productive activity in the valley. Given the requisite irrigation, however, the soil characteristics would allow for very profitable farming.

The project involves the construction of a group of basic works for the storage, conduction and distribution of the waters of the Rio Casqueva. It includes provision for surface flowoff, drainage, and service roads, as well as the necessary earth moving and land clearing in the area, which is presently covered by wild vegetation. The project also covers a number of efforts toward social betterment for the inhabitants of the area. The number of people dedicated to farming activities in the Secotuan valley is at the present time relatively small, and it is insufficient to accomplish the goals of the project. Hence, it is necessary to promote the settlement of the land area to be irrigated, and

to establish minimal satisfactory environmental conditions for the farmers of the region. The recommended social welfare programme is considered indispensable to the achievement of complete success of the proposed agricultural production programme.

The Panagua Project will be administered and operated by the Mendalvan Water Authority (M.W.A.), a public corporation formed in 1960 by the Ministry of Irrigation to promote the development of water resources in the entire western region of Galivia.

II. OBJECTIVES

The Panagua Project was designed with a view to a variety of objectives considered important by the Galivian Government in julging the merits of alternative investment programmes. These objectives include the following:

1. The promotion of increased economic and social productivity and increased consumption of goods and services.

2. The acceleration of the economic and social development of the region of Aendalva in which the project is carried out.

3. The distribution of benefits to the greatest number of inhabitants, and in particular to the small farmers of the area.

4. The generation of new occupational activities.

5. The promotion of better housing and sanitary conditions.

6. The production of exportable goods and services, and the minimizing of imports.

III.   THE CONSTRUCTION OF THE PROJECT WORKS

The central work of the project is the Panagua dam which will be constructed at the narrows of the Rio Casqueya, 75 river kilometers from the sea. The dam is of the earth-fill type, with a height of 40 meters, a length of 2,730 meters, and a width of 10 meters at the top and 170 meters at the base. The total capacity of the reservoir backed up by the dam will be 697 million cubic meters.

The main canal of the system will conduct water from the reservoir to the Secotuan valley. This canal will have a length of 58 kilometers, and will carry the full project discharge of 50 cubic meters per second. A pair of major lateral canals will then branch off to delineate the southern and western limits of irrigation of the region. The distribution system includes a series of small canals with a total length of 295 kilometers. These canals will be trapezoidal in cross section, and lined with concrete throughout their length in order to reduce conduction loss. The drainage system will have a total length of 385 kilometers, and will be constructed by means of straightening and widening the beds of the streams which cross the Secotuan valley. A road system will service the irrigated region, so that every land parcel will have access to a trunk road. The total length of the road system will be 235 kilometers. Finally, substantial tracts of land will have to be cleared for future cultivation. The total irrigable area of 40,000 hectares includes most of the best quality soil in the Secotuan valley.

In addition to these basic habilitation works, the project calls for a variety of social improvement works. It is proposed to concentrate the population benefited by the project in nine centers to be constructed throughout the region to be irrigated. One of these centers would have the public services required of an urban locality, and the remaining eight would be formed as villages with

rural characteristics. The urban center would require a substantial investment in ground levelling, access roads, street paving, water piping, sewerage, electrification, dwellings and offices, and other municipal facilities. The eight villages are not considered to require a heavy investment in urbanization. However, provision has been made for the construction of functional and hygienic housing for all of the small farmers to be settled in the valley, as well as a series of basic utilities including drinking water supply, health centers, electrification and school buildings.

The construction of the project works is expected to be carried out within a four-year period, at a total cost of 484 billion pesetas. In Table 1, the capital costs of the project are divided into their major component elements, and distributed over the envisaged four-year construction period. Table 2 further subdivides the capital cost of each component element into a number of broad input categories. It is assumed that the percentage distribution of expenditures among resource categories will remain roughly the same for each year of construction.

IV. THE AGRICULTURAL PROGRAMME

A. Land Ownership

The land area relevant to the project includes both the 40,000 hectares to be irrigated in the Secotuan valley, and the 6,800 hectares which will be covered by the reservoir created by the dam. The current distribution of land holdings in the total 46,800 hectares is highly unbalanced. As shown in Table 3, over 90% of the farmers hold less than half of the land, and less than 2% of the farmers hold close to 40% of the land.

In view of the government's interest in spreading the project benefits to the greatest possible number of farmers, the land tenure recommended for the project involves a substantial degree of equalization of holdings. The following considerations were observed in planning the distribution of newly irrigated land: 1) All of the farmers now holding land in the area to be irrigated, as well as these affected by the construction of the reservoir, should be furnished with parcels of a minimum of 10 hectares and a maximum of 50 hectares, in accordance with the size of their present landholdings. 2) The remaining land in the irrigable area should be withdrawn from the present owners and distributed in 10 hectare parcels among small landholders now living in adjacent regions. The resulting distribution of land ownership for the 40,000 hectares to be irrigated by the project is also shown in Table 3.

B. Crop Distribution and Production

Because of the lack of water, only 360 of the 40,000 hectares of land to be irrigated, and 1,090 of the 6,800 hectares where the reservoir is to be located, are currently under cultivation. All of the cultivated land is farmed only by season, and the principal crops are beans, corn, sesame and sorghum. The present figures on crop distribution and average annual production are shown in the first part of Table 4.

In formulating a cropping pattern to take effect after the completion of the project works, the planners sought to balance - on the one hand   the availability of water and the regional demand for different crops with - on the other hand - the dual objectives of maximizing overall economic benefits and raising the living standards of as many of the local farmers as possible. The resulting crop distribution is given in the second part of Table 4. The suggested distribution is adapted in particular to the predominance of small holdings which characterizes the future pattern of land ownership. It is assumed that cultivation will begin in the fifth year of the project - immediately after the construction of the works is completed. All of the crops are intended for domestic consumption with the exception of the tomatoes, which are destined for export to the United States.

The figures on expected future yields, prices and value of output given in Table 4 reflect the situation which is expected to obtain after the project is in full swing and the farmers have fully mastered the new techniques required for cultivation. It is expected that these conditions will prevail only after an initial learning period of 5 years. In the first year of cultivation (year 5), yields are anticipated to reach only one half of their ultimate level. In each of the following years, yields are projected to rise by 10% of their ultimate level until the maximum is reached by year 10. For the rest of the project life, yields are assumed to remain at this maximum.

C. Farmer Costs of Production

Table 4 brings out clearly the increase in yields - as well as the new variety of agricultural products - that will be made possible by the use of irrigation water in the Secotwan valley. At the same time, the costs of cultivation will necessarily rise as more farm equipment, more material inputs and more intensive labour are required for the irrigated land. The unit production cost per

hectare is shown for each crop - present and future - in Table 5. This unit
cost includes all expenditures on labour, material input, depreciation or rental
of equipment, interest on credit, and also the inputed value of family labour;
it excludes any charges made for irrigation water or for land rent. Table 5
also lists - for the area devoted to each crop - the total cost of production,
the total value of the produce (from Table 4), and the surplus remaining after
deduc ing cost from value of output. The last column of the table calculates
the unit surplus obtained from each crop; it will be observed that the new crops
introduced with irrigation generally provide a much larger surplus per hectare
than the old crops, with or without irrigation.

Table 6 presents a rough percentagewise breakdown of the total production
cost to the farmer (exclusive of irrigation fees) into its various component
elements, as projected for future cultivation on the irrigated land. Unfortunately,
this information was not available on a cropwise basis, and hence the average
figures must be applied to all of the crops under consideration. 40% of total
costs represent (unskilled) labour inputs, evaluated at the going market wage
rate; on the average, 3/4 of the labour is provided by the farming families
themselves. The remaining 60% of total costs cover current and capital material
inputs, as well as an allowance for interest on agricultural credit. The
provision of farm equipment, and the extension of agricultural credit, is to be
undertaken by the Ministry of Agriculture of the Galivian Central Government as
part of the overall project. The cost to the farmer of the equipment represents
a charge for rental of government-owned machinery which is calculated to cover
amortization with interest at a rate of 8% over the useful life of each machine.
The 2% allowance for interest represents payments made to the Ministry of
Agriculture for the supply of credit to finance approximately 50% of the cost
of production, for an average period of six months each year at the same interest
rate of 8%.

Just as the figures on yields and production in Table 4 represent the situation which is anticipated for year 10 - 5 years after the basic project works are completed - so the cost figures of Table 5 correspond to the ultimate input levels which will be required for the full yields. In the first few years, inputs as well as yields are expected to be below their final levels. For convenience, the same adjustment is made with respect to anticipated costs as to returns for each crop from year 5 to year 9: 50% in year 5, 60% in year 6, 70% in year 7, etc.

V. THE OPERATION OF THE PROJECT

Once the basic project works are completed, it will be the responsibility of the M.W.A. to operate, maintain and repair the works over their expected useful life of 50 years. Furthermore, the Ministry of Agriculture of the Galivian Central Government will undertake to provide the farm machinery and equipment necessary for the cultivation of the newly irrigated land; it will provide for the financing of the crops from sowing to harvest time; and it will also provide agricultural extension services in order to help to introduce the farmers to the required new methods of cultivation.

Table 7 presents the expected annual cost of operation, maintenance and repair of the works, as well as a breakdown of this operating cost into its major component elements. To help defray the operating costs, as well as part of the capital costs of the project, the cultivators will be required to make annual payments to the M.W.A. for the use of irrigation water at a rate of 500 pesetas per hectare. (This payment is not included as part of the costs of cultivation listed in Tables 5 and 6.) It will be observed from Table 5 that the average unit surplus for all of the irrigated crops is 1,700 pesetas per hectare; hence, the farmer has every incentive to make profitable use of the water, and there can be no doubt about his capacity to pay the irrigation fee.

The requirements of machinery and equipment for the agricultural programme were estimated at an average of 1,500 pesetas per hectare, or a total investment of 60 million pesetas. Since the intensity of cultivation - and the associated costs - are expected to rise gradually from 50% to 100% of their ultimate level during the initial years of the program, the Ministry of Agriculture will undertake to purchase 30 million pesetas' worth of equipment for the first year (5) and add an extra 6 million pesetas' worth in each of the five subsequent years.

The **average** life of the equipment - taking into account the need both for spare parts and for complete replacement - is estimated at approximately 10 years. Hence the Ministry must expect an average recurring expenditure on the equipment of 10% of its total value each year. For simplicity of calculation, these replacement expenditures are assumed to begin in year 10 - as soon as the complete stock of equipment is built up - and to continue at a constant rate for the duration of the Project. As noted earlier, the Ministry will charge the farmers an annual rental fee for the equipment used at a rate which will cover amortization with interest at 8% over the average equipment life of 10 years. Evaluated as a percentage of the total costs of cultivation, this fee amounts to the 15% shown in Table 6.

The supply of credit to the farmers is to be handled in the same way as the provision of equipment, except that there is, of course, no problem of replacement or amortization. Credit needs are estimated (from Table 6) at a rate of 53% of the costs of production; this covers the cost of all inputs other than family labour, which is assumed to require no advance credit, and farm equipment, which is separately financed. From Table 5, it will be seen that the total annual cost of cultivation of the 40,000 hectares of irrigated land amounts to 58.2 million pesetas of which 53% equals roughly 30 million. Since credit is needed for an average period of only six months, a revolving fund of working capital at a level of 15 million pesetas would be adequate to finance the costs of cultivation. It is assumed that the Ministry of Agriculture will build up such a fund in line with the credit needs of the farmers. 7.5 million pesetas in year 5, and an additional 1.5 million in each subsequent year until the final level of 15 million pesetas is reached in year 10. The farmers will be charged interest at a rate of 8% on the credit extended for 6 months; this is roughly equivalent to an annual interest rate of 4%, which applied to 53% of total costs - results in the interest payments of 2% shown in Table 6.

The provision of agricultural extension services to the farmers of the Secotuan valley will be made as part of the country-wide extension program administered by the Ministry of Agriculture. It is estimated that during the first six years of cultivation - from year 5 to year 10 - an intensive educational effort will have to be made to teach the farmers how best to cultivate the newly irrigated land. This effort will call for approximately one extension worker for every 20 holdings of land, or every 200 hectares. As a result, 200 extension workers will be needed each year for 6 years, at an average annual salary equivalent to 15,000 pesetas in domestic currency, and the annual cost to the Ministry of Agriculture will amount to 3 million pesetas. After the initial extension effort is completed, and yields reach their expected maximum levels, the need for extension workers will be correspondingly reduced. For the remaining years of the Project's useful life, the Ministry plans to allocate only 600,000 pesetas annually to cover the services of a total of 40 extension workers at an average rate of one per 1,000 hectares. The total costs incurred by the Ministry of Agriculture, in connection with the operation of the agricultural program of the Panagua Project, are presented in the accompanying Table 8.

VI. FINANCIAL ASPECTS OF THE PROJECT

The Panagua Project involves directly two separate branches of the Galivian Government: the Mendalvan Water Authority (M.W.A.) under the Ministry of Irrigation, and the Ministry of Agriculture. The M.W.A. incurs all of the expenditures in connection with the construction and operation of the Project works, and it receives the irrigation payments made by the farmers for the use of the water provided. The Ministry of Agriculture incurs the costs of the farm equipment, agricultural credit and extension services made available to the farmers under the agricultural program; it receives rental payments for the equipment and interest on the credit.

In order to finance the capital costs of the project, the M.W.A. will apply for loans from the World Bank and from the Galivian Central Government. It is proposed that the foreign exchange component of the investment, which amounts to $14.3 million or 143 million pesetas at the official exchange rate, be financed by the World Bank and that the remaining 341 million pesetas be covered by funds borrowed from the Central Treasury. The World Bank loan is to be amortized over a 20-year period following completion of the project works, with an effective rate of interest of 7% on the due balance. The Treasury will allow a 30-year term for amortization, with an interest rate of 5% on the due balance. In view of the nature and objectives of the Project, it is expected that both the World Bank and the Treasury will grant a grace period during the time of construction, and charge no interest until the new programme of agricultural production is underway.

The operating costs of the Project are incurred by the M.W.A. at an average annual rate of 4 million pesetas during the period of operation of the Project works, i.e., from years 5 to 54. The repayment of the construction loans is made

to the World Bank over the 20-year period from year 5¹ through year 24, and to the Treasury over the 30-year period from year 5 to year 34. Assuming that equal annual instalments are to be paid over the full term of amortization of each loan, the annual value of these payments can be calculated from annuity tables as follows:

WORLD BANK LOAN

    Ps. 143 million at 7% over 20 years
- = Ps. 143 million x 0.0944 annually
- = Ps. 13.5 million annually

TREASURY LOAN

    Ps. 341 million at 5% over 30 years
- = Ps. 341 million x 0.0651 annually
- = Ps. 22.2 million annually

As against these annual payments, the M.W.A. will receive annual irrigation fees from the farmers at a rate of 500 pesetas per hectare, or a total of 20 million pesetas per year.

Table 9 shows the gross cash payments and receipts of the M.W.A. for each year of the Panagua Project. During the first four years of the Project, the outlays on the construction of the works are exactly matched by the loans from the World Bank and the Central Treasury. From years 5 to 34, the loan repayment instalments and the costs of operation of the Project exceed the receipts from irrigation fees, so that there is a net cash outflow from the M.W.A. During the last twenty years, irrigation fees exceed operating costs and the M.W.A. registers net profits.

A similar balance sheet can be drawn up for the Ministry of Agriculture. The Ministry incurs programme expenditures as shown in Table 8, and receives payments for the equipment and agricultural credit from the farmers. These payments were evaluated as a percentage of the total annual farmer costs of cultivation (excluding irrigation fees) at 15% and 2%, respectively. Thus the annual rental receipts for the equipment rise from 4.36 to 8.73 million pesetas from year 5 to year 10, and the corresponding interest receipts for the credit rise from 0.58 to 1.16 million pesetas. All of the cash flows affecting the Ministry of Agriculture are listed for each year in Table 10. There is a substantial net cash outflow in year 5 - due to the purchase of farm equipment - and continued net outflows until year 10, after which the receipts from farmers catch up with the annual outlays.

While the M.W.A. and the Ministry of Agriculture incur most of the costs of the Panagua Project, the farmers to be settled in the irrigated area are the chief beneficiaries. Table 11 presents a cash flow account for the farmers as a group, in parallel to Tables 9 and 10. Farmer payments include the irrigation fees paid to the M.W.A., the rental and interest charges paid to the Ministry of Agriculture, and the remaining costs of cultivation listed in Table 6. With the exception of the irrigation fees, these costs are expected to rise in equal linear increments from year 5 to their maximum level in years 10 to 54. Farmer receipts for the sale of their agricultural output rise in the same manner, and remain well in excess of costs. Thus farmer net profits rise from an annual rate of 16.7 million pesetas to 53.4 million pesetas by year 10 of the Project.

VII.   EVALUATION OF THE PROJECT

The technical feasibility of the Panagua Project has been assured by
Messrs. Ramon y Roman, S.A., the engineering firm assigned by the Ministry of
Irrigation to design the works; their report appears as a separate technical
supplement. It remains now to consider the economic feasibility of the project
in order to evaluate its overall merit. A preliminary evaluation was carried
out by Sr. Esteban A. Nilgram, deputy managing director of the M.W.A., and was
submitted as part of the Project Report to the Galivian Central Budget Bureau.
Before taking any action, the Bureau decided to undertake its own analysis of
the Project, and delegated this task to a working group under the direction of
Dr. T. Emilio Blancabeza, a senior staff economist. After studying the report,
Dr. Blancabeza suggested an alternative approach to the evaluation of the
Project, and appended his comments and results to the Report.

A.   Sr. Nilgram's Analysis

It is proposed to appraise the economic feasibility and desirability of the
Panagua Project by comparing total benefits with total costs, and by examining
the computed overall benefit-cost ratio in the context of the general nature
and objectives of the Project. The main problems are to determine which are the
relevant benefits and costs, and to put these benefits and costs on a comparable
basis so that a meaningful ratio can be computed.

The costs of the Project works include capital costs for construction and
current costs for operation. Although the capital expenditures are made during the
first four years of the Project, these costs are met entirely by the loans from
the World Bank and the Central Treasury. Hence, from the point of view of the
M.W.A., the costs are the interest and amortization payments that must be made

to repay these loans. The time stream of loan repayments, as well as the annual operating expenses incurred by the M.W.A., thus represent the relevant costs of the Project works; they are distributed over years 5 to 54 as shown in Table 9.

The costs incurred by the Ministry of Agriculture for the accompanying agricultural program do not represent net costs for the Project as a whole. The expenditures on farm equipment and working capital are paid back by the farmers on the terms noted in Section VI, and the payment of salaries to agricultural extension workers is not really a net drain on the Ministry budget since these workers are likely just to be transferred from elsewhere in the country. In any case, the Panagua Project will be the responsibility of the M.W.A., and it is the benefits and costs as viewed by the M.W.A. which are of interest for the evaluation of the Project. Whether the Ministry of Agriculture chooses to assist the farmers on the Project irrigated land is a decision which is outside the scope of the M.W.A. and therefore of the Project itself.

The economic benefits of the Project are measured by the value of the irrigation water which is provided by the Project. It is recognized that the actual irrigation fees paid to the M.W.A. by the cultivators do not adequately reflect the value of the water, since even after paying their fees the cultivators will be substantially better off than before. To determine the real value of the water, it is proposed to compare the net surplus of the farmers under the currently prevailing crop system with their anticipated net surplus under the future crop plan for the affected area. The net surplus must be measured by subtracting from the value of agricultural production all costs other than fees for irrigation, so that the benefits directly attributable to the irrigation water may be isolated. This net surplus corresponds exactly to the concept of surplus defined in Table 5, and hence the figures from that table may be used in the calculation of the Project benefits.

From Table 5, it will be observed that the total annual surplus of production value over production cost is equal to 680,000 pesetas at present, and that this surplus is expected to rise to 73.4 million pesetas after the Project is completed. However, this maximum level of surplus will not be attained until year 10; in the first five years of cultivation - from year five through year nine - there will be shortfalls of 50%, 40%, 30%, 20% and 10%, respectively. Thus the corresponding surplus figures rise by equal linear increments of 7.34 million pesetas, from a level of 36.7 million pesetas in year 5 to 73.4 million pesetas in year 10.

The time flows of benefits and costs relevant to the evaluation of the Panagua Project may now be summarized as in Table 12. Benefits are measured by the difference between farmer surplus before and after the Project, and costs are equal to the sum of investment loan repayments and operating costs. The Project is clearly very desirable, because only in year 5 do total costs exceed total benefits; from year 6 on, benefits exceed costs by increasing margins.

To compute the benefit-cost ratio, it is proposed to calculate the equivalent annual values of the relevant flows shown in Table 12. In the case of the farmer surplus prior to irrigation, and the operating costs of the Project, there is no problem, since the annual flows remain constant over the 50-year period in question. To account for the shortfalls from years 5 to 9 in the farmer surplus after irrigation, the following correction is made on the ultimate average annual value of farmer surplus (73.4 million pesetas):

Total shortfall = (.5 + .4 + .3 + .2 + .1) x Ps. 73.4 m.
$$= 1.5 \times Ps. \ 73.4 \ m.$$

Total surplus over Project useful life
$$= (50 - 1.5) \times Ps. \ 73.4 \ m.$$

Average annual surplus = $(50 - 1.5) / (50) \times Ps. \ 73.4 \ m.$
$$= 0.97 \times Ps. \ 73.4 \ m. = \underline{Ps. \ 71.2 \ million}$$

To convert the loan repayments which are spread over 20 and 30 years into equivalent annual payments over 50 years, the annual World Bank payments are multiplied by 20/50 and the annual Treasury payments are multiplied by 30/50, with the following results:

Annual equivalent World Bank repayments = 2/5 (Ps. 13.5 m.)
$$= \underline{Ps. \ 5.4 \ m.}$$

Annual equivalent Treasury repayments = 3/5 (Ps. 22.2m.)
$$= \underline{Ps. \ 13.32 \ m.}$$

Using the equivalent annualized flows, it is now possible to compute the overall benefit-cost ratio as follows:

Farmer surplus with Project: Ps. 71.20 million
Farmer surplus without Project: -Ps. 0.68 million
                                 ─────────────────
                      BENEFITS   Ps. 70.52 million

World Bank loan repayment: Ps. 5.40 million
Treasury loan repayment: Ps. 13.32 million
Operating costs: Ps. 4.00 million
                              ─────────────────
                      COSTS   Ps. 22.72 million

$$\text{BENEFIT/COST RATIO} = \frac{\text{Ps. 70.52 m.}}{\text{Ps. 22.72 m.}} = \underline{3.1}$$

The benefit-cost ratio for the Panagua Project thus turns out to be 3.1, a high value which further attests to the desirability of the Project. Apart from its immediate economic appeal, the Project can be strongly recommended because of the many additional social and economic benefits which are not reflected in the benefit-cost ratio. These extra benefits include -

1) the provision of profitable employment to a great number of small farmers with limited incomes;

2) the promotion of a better geographical distribution of population, as well as more diversified agricultural production, by settling an almost deserted area;

3) the extension of basic social services to the people who will live in the Secotuan valley;

4) the expansion of agricultural production, which will stimulate the overall rate of economic development in the province of Mendalva.

For all these reasons, it is believed that the Panagua Project will make an important contribution both to the development of the national economy and to the welfare of the Galivian people.

B. Dr. Blancabeza's Analysis

The analysis of Sr. Nilgram appears to suffer from several serious defects, both on the procedural and on the conceptual level. As to procedure, Sr. Nilgram fails in his computations to recognize the role of time - the fact that benefits in early years are more valuable than benefits in later years. The methods used to annualize benefits and costs in effect imply that all benefits and costs are o f equal value whether they occur in year 5 or year 54; exactly the same benefit-cost ratio would have been obtained by summing all of the flows over the fifty-year period. To clear up the confusion caused by Sr. Nilgram's insistence on computing equivalent annual values, it is recommended that a discount rate be introduced to reflect the general preference for present over future benefits. Using this rate, all benefits and costs should be discounted back to a given year, and the total value of benefits and costs as of that year should be compared for the purpose of evaluating the Project.

The problem then becomes to choose an appropriate rate of discount. It was first suggested that this rate should reflect the ability of the Government

to raise funds by borrowing, and that therefore the current market rate of interest of 6% on long-term Government bonds should be used. It was later countered, however, that the rate of return on investment in the private sector - estimated at 15% - was the relevant figure, since public sector projects ought at least to meet private sector standards. After considerable discussion, a consensus was finally reached on a compromise figure of 10%.

Using this rate, each of the five time streams shown in Table 12 can be discounted back to year 0 (the present year) to yield the following total present values:

Farmer surplus with Project: Ps. 436.0 million

-Farmer surplus without Project: Ps.- 4.6 million

BENEFITS Ps. 431.4 million

World Bank loan repayment: Ps. 85.8 million

Treasury loan repayment: Ps. 156.7 million

Operating costs: Ps. 27.1 million

COSTS   Ps. 269.6 million

On this basis, the benefit-cost ratio turns out to be

$$\frac{\text{Ps. } 431.4 \text{ m.}}{\text{Ps. } 269.6 \text{ m.}} = 1.60$$

which is substantially less than the figure determined by Sr. Nilgram. The difference reflects the fact that the total value of benefits minus costs (as shown in Table 12) is lower in earlier than in later years, and the earlier years are the more important with a positive discount rate.

Apart from Sr. Nilgram's procedural mistakes, his general approach to the evaluation of the Project reflects too limited a conception of the national welfare. Although - as deputy managing director of the M.W.A. - he may feel that

his primary responsibility is to that organization, the commitment of public funds to investment in an undertaking such as the Panagua Project calls for scrutiny in the light of the national responsibility of the Galivian Central Government. Thus the expenditures of the Ministry of Agriculture on a project under the authority of the Ministry of Irrigation cannot be dismissed as irrelevant, for they too represent costs to the Galivian Government. Furthermore, all of the costs to the M.W.A. must be examined in order to determine to what extent they correspond to costs at the Central Government level. In accordance with these principles, several further adjustments are required for an adequate evaluation of the Panagua Project.

First of all, it is suggested that the capital costs of the Project be measured by the actual outlays on construction rather than by the loan repayments of the M.W.A. Whatever the obligations of the M.W.A., the Central Treasury will be required to find funds to pay for the domestic construction costs of the Panagua Project in years 1 to 4. All subsequent loan repayments from the M.W.A. to the Treasury simply represent accounting transfers from one agency of the Government to another, and therefore no real economic significance can be attached to them. As for the foreign exchange component of the construction costs, the issue is more complex. If the World Bank would make loans purely on the merit of individual projects, then the foreign exchange costs of construction of the Panagua Project would properly be equated with the required loan repayments. But it is felt that - by and large - an informal quota system applies to Bank loans to Galivia, so that a similar foreign exchange loan could be expected for an alternative project if - and only if - the Panagua Project were withdrawn. Under these circumstances, the Galivian Government can count on the availability of this foreign exchange in years 1 to 4, and the cost of using it for the Panagua Project should be measured by the loss involved in not using it elsewhere.

A second adjustment must be made to include the costs incurred by the Ministry of Agriculture in connection with the agricultural program of the Project. These costs include all of the payments listed in Table 10. In order to avoid double-counting, it is also necessary to subtract the receipts from the farmers for equipment and credit, since these have been included as farmer costs in calculating the farmer surplus. Just as the irrigation fees paid by the farmers to the M.W.A. represent simply transfer payments and are not relevant to the evaluation of the water benefits, so the rental and interest charges paid to the Ministry of Agriculture are cash transfers which do not necessarily measure the real costs of equipment and credit. These costs are properly measured by the original outlays by the Ministry; these outlays are hence to be added to the costs of construction and operation of the Project works, and the farmer payments must be netted out.

On the benefit side of the ledger, the method for assessing the value of the irrigation water is accepted as proposed by Sr. Nilgram. It is worth noting that the value of the water - measured in this way - clearly depends upon the provision of agricultural assistance from the Ministry of Agriculture, and it is therefore essential to include the costs of this assistance in evaluating the Project as a whole. Apart from the benefits to the farmer arising from the sale of agricultural output, there are also additional benefits due to the housing and social services provided by the "social improvement works" of the Project. Since the costs of these works are charged to the Project, the corresponding benefits should also be included. It is estimated that the annual value of these benefits - realized from year 5 through year 54 - is equal to 7% of the total capital investment of 40 million pesetas, which comes to 2.8 million pesetas per year.

Taking into account all of these modifications, the benefits and costs of the Panagua Project may now be summarized as in Table 13. By comparison with Table 12,

total costs are now much more concentrated in the early years of the Project, and the excess of benefits over costs is higher in the later years. It is no longer obvious that the Project is desirable - that will depend on the relative importance of the early vs. the later years, i.e., on the discount rate.

Using the discount rate of 10% suggested above, each of the time streams shown in Table 13 can be converted to its present value in year 0 as follows:

Farmer surplus with Project:	Ps. 436.3 million
-Farmer surplus without Project:	Ps. - 4.6 million
Housing & social services:	Ps. 19.0 million
BENEFITS	Ps. 450.7 million

Construction of Project works:	Ps. 369.3 million
Operation of Project works:	Ps. 27.1 million
Agricultural assistance:	Ps. 77.9 million
-Net of Farmer Payments:	Ps. -58.8 million
COSTS	Ps. 415.5 million

The benefit-cost ratio is thus

$$\frac{\text{Ps. }450.7}{\text{Ps. }415.5} = \underline{1.08}$$

which is lower than the earlier value of 1.60 largely because - at a discount rate of 10% - it is more expensive to pay for construction outlays as they are incurred than to finance them with loans at rates of interest of 5% and 7%.

While the benefit-cost ratio is an indicator of the relative margin of benefits over costs, it tells nothing about the absolute size of the gains from the Project. It is quite possible that a large Project with a low benefit-cost ratio would provide greater net benefits than a small Project with a high benefit-cost ratio, so that - if the two are mutually exclusive - the first might be preferred. Given this ambiguity, it is proposed that attention be given also to the net present value (PV) of the Project, defined as the difference

between the present value of benefits and costs. Thus we derive

$$PV = Ps. \ 450.7 \ m. - Ps. \ 415.5 \ m.$$

$$= \underline{Ps. \ 35.2 \ million}$$

from the figures which yielded a benefit-cost ratio of 1.08: the Panagua Project

results in a net gain to Galivia worth 35.2 million pesetas at the present time.

The benefit-cost ratio of 1.08 is much lower than the value of 3.1 originally

calculated by Sr. Nilgram; it corresponds to a present value of net benefits of

only 35.2 million pesetas, as compared with a total commitment of funds worth

415.5 million pesetas. These figures suggest that the Project makes only a

marginal contribution to the economic welfare of the nation. However, in view

of the significant social and economic benefits which - as observed by Sr.

Nilgram - could not adequately be reflected in the benefit-cost computations;

the Panagua Project is still strongly recommended for approval.

PART II

A SOCIAL BENEFIT-COST ANALYSIS

OF THE PANAGUA PROJECT

I. INTRODUCTION

Before proceeding to the social benefit-cost analysis of the Panagua Project, it will be useful to comment briefly on the evaluations described in Part VII of the Project Report. The initial evaluation made by Sr. Nilgram was criticized by Dr. Blancabeza, who suggested a number of adjustments and presented an alternative evaluation. Dr. Blancabeza correctly pointed out that the Panagua Project should be evaluated in terms of benefits and costs to the Galivian nation as a whole, and he properly insisted on the recognition of society's preference for present over future gains. While Dr. Blancabeza's analysis represents a substantial improvement over Sr. Nilgram's effort, it still raises many problems which are not satisfactorily solved.

The first problem relates to the concept of national welfare. Unless planners are given some notion about the meaning of national welfare, it is of course impossible for them to evaluate the net contribution - benefits minus costs - of any given project to this national welfare. The meaning of national welfare is generally articulated in the objectives set by the national government, which should in turn reflect the best interests of the people to whom it is responsible. Some of the principal objectives of the Galivian Government were set out in Part II of the Project Report. In addition to promoting economic growth and higher consumption levels of the country as a whole, the Government has a special concern for the economic development of the Mendalvan region, for the social welfare of the inhabitants of that region, and for the alleviation of balance of payments problems.

In the evaluation made by Dr. Blancabeza, explicit consideration was given only to overall economic benefits and costs. The distribution of the benefits and the costs, the social implications of the Project, and its effect on the

balance of payments, were all omitted from the calculations. The importance of
these additional considerations, however, emerges clearly from the recommendation
made by Dr. Blarcabeza. In spite of a very low value for the benefit-cost ratio,
approval of the Panagua Project was urged on the grounds that the Project
contributed significantly to the economic and social development of a relatively
poor region of the country. Thus the numerical benefit-cost ratio calculated
purely on the basis of contributions to the overall economic growth of Calivia
proved to be of only limited relevance, and was ultimately obscured by other
considerations. In principle, it would clearly be most desirable to give
quantitative expression to all of the relevant Government objectives, and to
incorporate them into a generalized benefit-cost analysis for greater usefulness
in decision-making.

A second general problem raised in the analysis of Dr. Blancabeza concerns
the evaluation of resources from a national point of view. Dr. Blancabeza
correctly stressed that the value of a resource should be measured with reference
to the alternative possibilities for its use; an input into a project costs the
economy whatever benefits it would have enjoyed by using that input elsewhere.
Thus Dr. Blancabeza measured the capital costs of the Panagua Project in
terms of construction outlays rather than loan repayments, because he felt
that the relevant alternative to using the Bank and Government loans for the
Project was not the liquidation of the debt, but the use of the same funds for
other purposes.

The logic of resource evaluation according to opportunity cost (value in
alternative use) raises further problems with which Dr. Blancabeza did not deal.
It becomes necessary to evaluate each input - as well as the output - of a
project according to its opportunity cost, and to recognize that the opportunity
cost may well differ from the actual market price of a product. Such differences

can arise for a variety of reasons, including the imperfect functioning of the
market system, the inadequacy of even a perfectly functioning market system, and
the political and institutional constraints which prevent the government from
correcting what it considers to be a misallocation of resources. Examples of
market price deviations from true (social) opportunity cost are plentiful,
particularly in relatively undeveloped economies. If the national currency is
pegged at an officially fixed exchange rate with foreign currencies, and if
this rate is maintained by import and export controls, then it is very likely
that the opportunity cost of foreign exchange is above the official rate of
exchange. If there is a significant degree of unemployment in the country, then
the opportunity cost of unskilled labour may well be below the market wage. If
the rate of saving and investment in an economy is lower than the rate which the
nation as a whole would judge optimal, then the opportunity cost of investment
is higher than would be reflected in market prices.

In all of the examples mentioned, the relevant opportunity cost is a
"social" cost in the sense that it corresponds to national rather than private
or otherwise more limited objectives. The problem of evaluation arises because
social preferences - as articulated in national objectives - may not be properly
transmitted by the market system into the pricing of goods and services. In
such cases, the evaluation of projects from a national point of view calls for
the adjustment of market prices to reflect the underlying social opportunity
costs. While in practice it is not possible to adjust every price involved in
the evaluation of a project, it is important to make corrections in the case of
major and evident discrepancies. Thus, in addition to incorporating explicitly the
multiplicity of government objectives into benefit-cost analysis, it is necessary
on a tactical level to recognize that market prices may be imperfect measuring
rods, and to correct such prices wherever possible to reflect the relevant
opportunity costs.

branches of the Galivian Government - the M.W.A., the Ministry of Agriculture, etc., for they all operate under a common budget. Each of the benefit and cost flows that enter into SC, as defined in equation 2, can be identified with one of these four groups. The market value of agricultural production (1) accrues to F, whether the crops are sold on the market or retained for home consumption. The extra value of foreign exchange earned by tomato exports

φ (1-F) accrues to G, for the Galivian Government is assumed to pay farmers for their foreign exchange earnings at the official exchange rate, and therby capture for its own use the excess value of the foreign exchange. The benefits of housing and social services (2) are gained by F.

The identification of the group which pays for construction costs $_{\wedge}$ depends (3) upon the manner in which these costs are financed -- in particular, from whom the corresponding resources are ultimately diverted. If the construction costs of the Project are paid out of Government revenues without any corresponding receipts, then G is the loser. However, if the Government finances the cost of construction through additional taxation or borrowing, then the holders of taxed or borrowed funds are the losers. In the case of the Panagua Project, part of the cost is financed by a World Bank loan and the rest by the Galivian Government. It has been assumed that the Bank loan would have been available to the Government in the same terms in the absence of the Panacua Project; hence, it is G which pays for the foreign exchange component (3-F), which it could have used on an alternative project. In addition to the market value of the foreign exchange component, G also loses the extra opportunity cost represented by φ (3-F). In the case of the domestic currency funds provided out of the Galivian budget, it is assumed that the money is raised by general taxation (or - equivalently - that in the absence of the Panagua Project, taxes would have been reduced). The effect is that resources are diverted

away from the taxed public, and the construction cost components (3-S), (3-D) and (3-L) are paid for by T.

The costs of operating the Project works (4), and the costs of the farm equipment (6-F) and working capital (6-D) provided by the Ministry of Agriculture, are all paid for by G; and the additional opportunity costs due to the foreign exchange components φ(4-F) and φ(6-F) are also sustained by G. In the case of the agricultural extension services - whose total value is measured by $[1 + \lambda^{\varepsilon}]$ (6-S) - the loss is borne by those farmers (F) away from whom the extension workers are drawn by the Ministry to be assigned to the Panagua Project. The costs of agricultural production paid by the cultivators (5), as well as the value of net agricultural income foregone (7), are losses to F. However, the extra opportunity cost of foreign exchange φ(5-F) is borne by G, since the Galivia Government is in effect subsidizing the use of imported inputs in agriculture by making them available to the farmer at the official exchange rate. It remains only to consider the (negative) costs included in SC which are represented by the unskilled labor premiums λL (as defined in equation 2). These premiums correspond to the margin by which the total Project wage bill for unskilled labor - including farm labor - exceeds the amount necessary to attract the unskilled workers to the Project, i.e., their earnings in alternative employment plus the costs of transfer. This margin corresponds exactly to the net extra income which is received by the unskilled labor on account of the Project, so that the (negative) costs λ [(4-L) + (5-L^H) + (6-L)] accrue to L, and the remaining (negative) costs λ (5-L^F) goes to farm labor belonging to F.

Although the cash transfer items (8), (9) and (10) are not relevant to the evaluation of aggregate benefits and costs, they are very relevant to the

A few additional issues - primarily on the tactical level - are also raised by Dr. Blancabeza. What is the appropriate rate of discount to be used in evaluating public projects? And what is the appropriate criterion: the benefit-cost ratio, or the net present value of the project? These questions can be answered only in the context of the generalized kind of social benefit-cost analysis outlined in the preceding paragraphs. Provided that alternative opportunities have been properly accounted for in terms of the social opportunity costs discussed above, the rate of discount applied in comparing contributions to a given national objective at different points in time should reflect the intertemporal time preferences held by the government - as proxy for the people - with respect to that objective. The market rate of interest, or the rate of return on investment in the private sector, are not appropriate in this context, for the alternative uses of investment funds are already accounted for in the estimation of the opportunity cost of investment. If, in addition to the proper use of social opportunity costs, the multiplicity of national objectives are reflected in the quantitive calculations, it behooves the government to undertake all projects for which the net present value of (social) benefits is positive, irrespective of the magnitude of the benefit-cost ratio.

In conclusion, it is apparent that a complete evaluation of the Panagua Project calls for a detailed application of social benefit-cost analysis which goes well beyond the effort of Dr. Blancabeza. The principles and methodology of social benefit-cost analysis - touched on in the preceding paragraphs - are explained at much greater length in a separate manual. In the following part of this report, an illustrative analysis will be carried out to evaluate the Panagua Project from the social point of view.

II. OBJECTIVES

The evaluation of a project according to social benefit-cost criteria begins with the explicit statement of the relevant social objectives. With reference to the Panagua Project, a variety of Galivian government objectives were listed in Part II of the Project Report. These objectives may be restated as follows: 1) increased aggregate consumption - the raising of the average standard of living in Galivia as a whole; 2) redistribution of income to the region of Mendalva - the promotion of regional as opposed to national economic welfare; 3) redistribution of income to small farmers - the distribution of benefits to the greatest number of beneficiaries; 4) the provision of new employment opportunities; 5) the provision of basic social welfare facilities; and 6) the reduction of pressures on the balance of payments.

The first three objectives are clearly quite distinct, and the net contribution of the Project to each of them must be separately assessed. The last three objectives may or may not be subsumed by the first. Thus more employment opportunities may be desired primarily for the contribution that a larger working force could make to national income and hence to consumption. Only if additional employment is considered desirable for its own sake should it be regarded as a separate objective. In the case of social welfare facilities, a separate objective is involved only if the government wishes to give more weight to such facilities than would the Galivian people in their capacity as consumers. Finally, a separate objective of improvement in the balance of payments is justified only if the government's concern goes beyond the promotion of aggregate consumption through an optimal policy of foreign trade. In all likelihood, the last three items do not so much represent separable objectives as observations on the inadequacy of market prices - the wage rate, the price

of social services, and the foreign exchange rate - to reflect true social

benefits and costs with respect to the aggregate consumption objective. Thus,

in the analysis to follow, explicit consideration will be limited to the first

three stated objectives: aggregate consumption, regional (Mendalva) redistribution,

and group (small farmer) redistribution.

The analysis proceeds by evaluating separately the net contribution of

the Panagua Project to each of these three objectives, and subsequently

combining the contributions with weights reflecting the relative importance

attributed by the Galivian government to each objective.

III. BASIC DATA REQUIREMENTS

The information base required for social benefit-cost analysis is substantially greater than for the cruder methods of evaluation used in the Panagua Project Report. On the one hand, more detail is required in the description of the benefits and costs of a project, so that different items can be distinguished according to the contributions that they make to different objectives, and according to the need for adjustment of market prices. On the other hand, additional information is required on the national level regarding the relative weights given to alternative objectives, and regarding a number of parameters used in the adjustment of market prices to reflect social opportunity costs. This latter information is common to the evaluation of all projects, and must be provided from above by government authorities.

A basic core of essential data on the project level was presented in Tables 1-8 of the Panagua Project Report, although much of the detail was not used in the earlier evaluations. These data have been recompiled and presented in a more useful format in the accompanying Tables 14 through 16. Table 14 displays the costs of construction of the Project works, divided according to year and type of input, but summed over all of the different elements of the works listed in Tables 1 and 2 of the Project Report. Table 15 presents a parallel breakdown of the costs of operation and maintenance of the Project works; these costs are assumed to remain constant throughout the useful life of the Project. Tables 16 and 17 list the costs of agricultural production borne by the cultivators and by the Ministry of Agriculture, respectively, and also include yearwise detail on input categories. Farmer costs - other than irrigation fees - rise in equal linear increments from one half to their full

level by year 10; government costs show a different trend Finally, Table 16
gives a similar picture of the time pattern of Project benefits. Agricultural
production rises with costs from year 5 to year 10; the foregone benefits of
agricultural production prior to the Project are constant throughout; and the
annual value of housing and social services also remains in constant proportion
to the corresponding original fixed investment.

In addition to the underlying figures described in the preceding paragraph,
each table also includes a regrouping of inputs and outputs according to the
resource category to which each belongs. A few of the benefit and cost flows
do not correspond to real resource flows, and these are separated out as cash
transfers.

In the analysis to follow, it will be necessary to distinguish between
imported and domestically supplied material inputs, and between different types
of labor; it will also be necessary to distinguish export earnings from domestic
sales. Thus the resource categories. used for grouping the resource flows
are as follows: unskilled labor, skilled labor, domestic inputs (output)
and foreign exchange inputs (output). Machinery and parts, iron and steel,
fuel, chemical fertilizers and pesticides are all currently imported into
Galivia - and it will be assumed (for convenience of computation) that they
continue to be imported throughout the life of the Project. All other material
imputs are produced domestically. On the benefit side, the tomato crop is
exported and earns foreign exchange, while all other crops are sold on the
domestic market. Skilled laborers - engineers, technicians, managers, etc. -
are already distinguished as such in the Project Report tables. For the
purpose of the analysis, semi-skilled machinery operators, and agricultural
extension workers will also be classified as skilled laborers. The remaining
labor inputs--including all farm laborers - are assumed to be unskilled.

Table 19 provides a comprehensive summary of all of the flows brought about by the Panagua Project which will be required in the analysis to follow. The benefit flows are measured by the sales value of agricultural output, and the (imputed) value of housing and social services, each of which corresponds to a real benefit to Galivia. The cost flows are measured by the outlays on construction, operation and cultivation which correspond directly to the use of resources. Hence land compensation, irrigation fees and rental and interest payments are listed separately under cash transfers. Agricultural income foregone was listed in Table 18 as a negative item under benefits, but it may also be considered a proxy for the real cost of land use, and it is thus listed in Table 19 as a positive item under costs. The value of each of the principal benefit and cost flows is subdivided - wherever applicable -- according to the shares attributable to each of the resource categories distinguished in Tables 14 to 16. All of the values shown in Table 19 - like the figures in the earlier tables - are based on prevailing market prices. In the case of imported inputs and exported output, the peseta value is obtained by applying the official exchange rate (10 pesetas to a dollar) to the foreign currency involved.

In addition to the project level data summarized in Table 19, values are required for a set of parameters which serve to place the Panagua Project in the national context in which it must be evaluated. These parameters will be defined as they are required in the measurement of benefits and costs, and in the reconciliation of multiple objectives, during later stages of the analysis. The actual values of the parameters, which are assumed to apply in the Galivian context, will then be introduced as a basis for the final numerical benefit-cost evaluation of the Project.

IV. THE AGGREGATE CONSUMPTION OBJECTIVE

A consumption benefit is defined as an increase in the time stream of consumption possibilities available to the beneficiary, and a consumption cost is simply a corresponding decrease. Thus when an individual receives a net increase of earnings of $100, his consumption benefit is equivalent to the value of the time stream of consumption flows that he may purchase for $100. If he spends all of the money on consumption goods when he receives it, the consumption benefit is equal to $100. If he saves part of this sum, earns a return on his saving, and then spends the augmented remainder on consumption goods in a later period, the value of the consumption benefit is the sum of the value of his immediate consumption expenditure and the discounted value of his future consumption. The contribution of a given project to the aggregate consumption objective is simply the unweighted sum of all consumption benefits to individuals (including the government as representative of the community of individuals), minus the unweighted sum of all corresponding consumption costs.

The evaluation of the net aggregate consumption benefits of the Panagua Project is most clearly carried out in successive stages of approximation. The first - and most straightforward - step is to assess the benefits and costs under the assumption that market prices adequately represent social opportunity costs - and hence, the ultimate consumption benefits and costs involved. On this basis, the consumption benefits of the Project include items (1) and (2) in Table 19 and the consumption costs include items (3), (4), (5), (6) and (7).

Items (1) and (2) correspond to real gains for the Galivian economy as a whole, which would not have come about in the absence of the Panagua Project. Analogously, items (3) through (6) represent payments for resources that could

have been used elsewhere - were it not for the Project - and which therefore measure the sacrifice of consumption possibilities that the Galivian economy sustains because of the Project. Item (7) measures directly the consumption sacrifice involved in giving up the previously farmed land to new methods of cultivation. The last three items (8) to (10) do not enter into the aggregate consumption calculations, for they represent gains to one group of people which are exactly offset by losses to others, and hence have no net effect on the aggregate welfare.

The market value of net aggregate consumption benefits in any given year of the Project may thus be defined as follows:

[1] MC = (1) + (2) - (3) - (4) - (5) - (6) - (7)

MC represents the first approximation to the net aggregate consumption benefits of the Panagua Project. The second approximation involves the adjustment of the market prices of specific resources, wherever these prices do not reflect the real contribution of the resources to the aggregate consumption objective - i.e., their "social opportunity cost". As noted earlier, such discrepancies can occur for a variety of reasons and in a variety of ways. In the evaluation of the Panagua Project, two major resources are singled out for price adjustment: foreign exchange and unskilled labor. In addition, it is observed that agricultural extension workers contribute more to national output than is measured by their wage. It is tacitly assumed that all of the remaining inputs and outputs of the Project are correctly priced by the competitive market mechanism - i.e., that there is no rationing (at artificially low prices) or unemployment (at artificially high prices) of any other factors, goods or services.

In the case of foreign exchange, it is noted that heavy pressure on the Galivian balance of payments has resulted in strict quantitative import controls and export subsidies to maintain the dollar value of the peseta. As a result, it is clear to all concerned that a dollar of foreign exchange is worth substantially more than 10 pesetas - its value at the official exchange rate. Under these circumstances, it is essential that a quantitative assessment of the social opportunity cost of foreign exchange be made by the central authorities and used to price foreign exchange in the evaluation of individual projects. Such a calculation can only be made on the basis of comprehensive information about the economy-wide demand for imports and supply of exports, present and future, taking into account the nature of the overall development strategy, the availability of foreign economic assistance, and world trade prospects in general. It is a difficult calculation to make - particularly in view of the likelihood that the social opportunity cost of foreign exchange will change over time - but it is important for some quantitative estimate to be made so long as the official rate appears ·inappropriate. In the analysis to follow, the opportunity cost of foreign exchange relative to its official market price will be denoted by $(1 + \partial)$. ∂ represents the foreign exchange premium, which is currently positive in Galivia, but may decline over time.

The case of unskilled labor in Galivia is opposite to that of foreign exchange; where foreign exchange is effectively rationed at a price well below its opportunity cost, unskilled labor is often found in surplus, and the market wage may well exceed the opportunity cost of employing additional workers. The estimation of the opportunity cost of unskilled labor is more complex than for foreign exchange, since different types of labor as well as the extent of regional immobility of labor must be taken into account. The relevant opportunity cost of unskilled labor for a given project will depend upon the nature of

the work to be done, the location of the project and the location of the potential work force. To make an adequate assessment, information is required both about the project itself and about the supply of labor in the relevant region, and in the country as a whole. The opportunity cost of unskilled labor - relative to the going market wage - will be denoted by $(1 + \lambda)$. λ represents the unskilled labor premium, which is likely to be negative in the Mendalvan region and especially insofar as the rurally-oriented Panagua Project is concerned.

Although skilled laborers in general are assumed to be fully employed in Galivia at wages which reflect their social opportunity cost, agricultural extension workers in particular are regarded as underpaid by the Ministry of Agriculture. The social value of an extension worker is measured by the contribution his services make to aggregate consumption benefits for Galivia, via improved agricultural production techniques. Since there is such a pressing need in many parts of the country for farmer instruction, the marginal extension worker is in a position to contribute much more than the wage he commands. In parallel with φ and λ, λ^{E} is defined as the social premium on the market wage of an agricultural extension worker; λ^{E} is expected to remain positive in Galivia for a considerable period of time.

It is now possible to express the net aggregate consumption benefits of the Panagua Project - after incorporating the opportunity cost premiums - as

[2] $SC = (1) + \varphi(1-F) + (2) - (3) - \lambda(3-L) - \varphi(3-F)$

$-(4) - \lambda(4-L) - \varphi(4-F) - (5) - \lambda(5-L^{F}) -$

$\lambda(5-L^{H}) - \varphi(5-F) - (6) - \lambda^{E}(6-S) - \varphi(6-F) - (7)$

Rearranging the terms, equation 2 may also be written as follows:

[2*] $SC = MC + \varphi F + \lambda L + \lambda^{E} E$

[2a]   where $F = (1-F) - (3-F) - (4-F) - (5-F) - (6-F)$

[2b] $L = -(3-L) - (4-L) - (5-L^{F}) - (5-L^{H})$

[2c] $E = -(6-S)$

The second approximation SC is obtained by adding three terms to the first approximation MC. Ther first term corrects MC for the opportunity cost of foreign exchange by multiplying the net foreign exchange component F of benefits and costs by the (positive) foreign exchange premium φ. The second term corrects MC for the opportunity cost of unskilled labor by multiplying the net unskilled labor component L by the (negative) labor premium λ: and the third term does the same for agricultural extension workers with their (positive) premium λ^E.

The third and final approximation to the net aggregate consumption benefits of the Panagua Project takes into account the adjustments necessary when the social value of funds devoted to investment exceeds the social value of the same funds devoted to consumption. This possibility can and will arise when the limitations of the Galivian Government's fiscal and monetary powers prevent it from bringing about the rate of investment which - in its capacity as representative of the Galivian people - it deems optimal for the country as a whole. Typically, the Government will not be in a position to raise savings - and investment - to the point where the marginal rate of return on investment (r) is brought into equality with the social rate of discount (i) which reflects the intertemporal time preferences of the nation. Under these circumstances, it can be shown that the social value of investment exceeds the social value of consumption. This point can be seen intuitively through the observation that a dollar invested in one year becomes $S(1 + r)$ in the following year. If the $S(1 + r)$ is consumed, the value of the consumption - discounted back to the first year at the rate i - remains greater than 1. Hence, the ultimate consumption benefits which flow from a dollar invested today exceed a dollar's worth of consumption today.

The opportunity cost of investment, $\bar{p}$, is defined as the ratio of the social value of investment to the social value of consumption - where 'social value' is understood to mean the value of the relevant time stream of aggregate consumption benefits discounted back to the present at the social rate of discount. The value of $\bar{p}$ can be determined according to the following formula:

$$(3) \qquad \frac{(1 - \mu) \gamma}{i - \mu \gamma}$$

where i and γ are defined as above; μ is the economy-wide marginal rate of re-investment of profits, expressed as a fraction of total profits; and all three parameters are assumed to remain constant over time. Values for i, γ and μ must be determined by a central planning authority and used consistently for the evaluation of all projects.

Once it is recognized that $\bar{p}$ does not equal 1, it becomes essential to evaluate the net effect of the Project on the mix of consumption and investment in the economy. To the extent that the Panagua Project results in a net increase of investment relative to consumption in any given year, the corresponding aggregate consumption benefits - evaluated at the relevant social rate of discount - are increased above the level measured by the second approximation SC. In order to evaluate the net effect of the Project on the rate of investment, it is necessary to distinguish all of the benefit and cost flows that make up SC - as well as the accompanying cash transfers - according to the group which gains or loses, and to estimate the respective marginal consumption and saving propensities of each group.

For this purpose, four broad groups of gainers and losers have been distinguished with respect to the Panagua Project: farmers (F), unskilled laborers (L), the Government (G) and the taxed public (T). G includes all

distribution of these benefits and costs. Hence, they too must be considered here in assessing the allocation of net benefits among the four groups F, L, G and T. Item (8) represents a gain to the landowners among F, and an equal loss to G. Items (9) and (10) represent costs to F, and corresponding benefits to G. Since these items enter both as benefits and costs, the sum total of net benefits to the four groups remains equal to the total net benefits SC.

The distribution of second approximation net consumption benefits SC by group can now be summarized as follows:

[4] $\quad SC = SC^F + SC^L + SC^G + SC^T$

[4a] $\quad SC^F = (1) + (2) - (5) - (6-S) - (7) + (8) - (9) - (10) - \lambda (5-L^F) - \lambda^E(6-S)$

[4b] $\quad SC^L = - \lambda [(3-L) + (4-L) + (5-L^H)]$

[4c] $\quad SC^G = - (3-F) - (4) - (6-D) - (6-F) - (8) + (9) + (10) +$

$\quad\quad\quad\quad \varphi [(1-F) - (3-F) - (4-F) - (5-F) - (6-F)]$

[4d] $\quad SC^T = -(3-L) - (3-S) - (3-D)$

where SC^F, SC^L, SC^G and SC^T represent the value of net consumption benefit flowing to F, L, G and T, respectively. To arrive at the final social value of net aggregate consumption benefits, C, it is necessary to correct SC^F, SC^L, SC^G and SC^T according to the proportions in which each is divided between consumption and investment. Thus if the average farmer saves a proportion σ^F of his marginal gains, the social value of the net consumption benefits flowing to farmer is

[5a] $\quad C^F = [\sigma^F \bar{p} + 1 - \sigma^F] SC^F$

Similarly, the social value of net consumption benefits flowing to unskilled laborers, to the government, and to the taxed public, can be expressed as follows:

[5b] $\quad C^L = [\sigma^L \bar{p} + 1 - \sigma^L] SC^L$

[5c] $\quad C^G = [\sigma^G \bar{p} + 1 - \sigma^G] SC^G$

[5d] $\quad C^T = [\sigma^T \bar{p} + 1 - \sigma^T] SC^T$

The values for the marginal rate of saving of each relevant group constitute another body of data that cannot be determined at the project level, but which must be provided from a central source.

We may now write the third and final approximation to the value of net aggregate consumption benefits C to Galivia as a whole, in any given year, as the sum of the social value of net benefits flowing to each distinct group:

[5] $C = C^F + C^L + C^G + C^T$

Using equations 5a to 5d, equation 5 may be rewritten as follows:

[5*] $C = SC + (\bar{p} - 1) [\sigma^F SC^F + \sigma^L SC^L + \sigma^G SC^G + \sigma^T SC^T]$

Thus the final approximation C is equal to the second approximation SC, corrected by a term which multiplies the total marginal savings out of net project consumption benefits by the excess of the social value of investment over the social value of consumption $(\bar{p} - 1)$.

V. THE REGIONAL REDISTRIBUTION OBJECTIVE

The second national objective to be considered in the evaluation of the Panagua Project is the objective of redistributing benefits to the relatively underdeveloped Mendalvan region of the country. It is now necessary to review the benefits and costs of the Panagua Project in order to assess their net effect on the welfare of Mendalva. Some of the benefit and cost flows shown in Table 19 are relevant to Mendalvan welfare, and others are not: those items which are relevant may affect the redistribution objective in a different way than the aggregate consumption objective.

The market value of agricultural production (1) clearly represents a direct benefit to Mendalva, since the earnings flow to the farmers of the region. The extra value of the foreign exchange component of (1-F), however, does not result in a benefit for the region since it is captured by the Galivian Central Government. Clearly, the value of housing and social services (2) is also included among the direct benefits to Mendalva.

Among the cost flows, only the agricultural production costs of the farmers (5) and the net agricultural income foregone (7) represent losses to Mendalva. But to the extent that farmer costs result in net gains to other inhabitants of Mendalva, a compensating benefit is involved. Payments to the government and payments for imported inputs clearly go out of Mendalva and represent pure losses to the region. Payments for domestic inputs produced in Mendalva - e.g. fodder and seeds - as well as wages paid (in cash or in kind) to inhabitants of Mendalva would appear not to represent net costs to the region. This, however, requires more careful attention. When the farmer buys fodder and seeds in Mendalva, the total supply of these materials available in the region must be reduced, or the flow into the region must be increased, or the

production within the region must be stepped up. Whichever the case, there is indeed a net cost to Mendalva unless otherwise idle Mendalvan resources are put to use. Thus the likelihood is that farmer payments for domestic materials do represent costs to the region, just as do payment to the Government and for imported inputs.

The situation in regard to wage payments, on the other hand, is different. When workers are put to work in Mendalva, there is no corresponding reduction in the regional labour force, because it can safely be assumed that there will be a corresponding marginal immigration of labour into the region. Thus it is most likely that - in contrast to payments for material inputs - wage payments will remain within the region and result in benefits for inhabitants of Mendalva. Accordingly, the wage component of farmer production costs, $(5-L^F)$ plus $(5-L^H)$, must be added in as a compensating benefit to the regional cost of (5). By the same token, the wage payments made by the M.W.A. for the construction and operation of the Project, and the payments made by the Ministry of Agriculture to extension workers, also result in net benefits to Mendalva. These wage payments are made both to skilled and unskilled workers, and are covered by items (3-L), (3-S), (4-L), (4-S) and (6-S).

Just as the cash transfer items (8), (9) and (10) had to be taken into account in evaluating the allocation of net benefits among groups, so they must be considered in assessing the distribution of net benefits to the Mendalvan region. Item (8) enters as a benefit to Mendalva, while items (9) and (10) clearly represent costs to the region. The total value of net aggregate consumption benefits redistributed to the Mendalvan region in any given year can now be expressed as follows:

[6] $DR^M = (1) + (2) + (3-L) + (3-S) + (4-L) + (4-S) - (5) + (5-L^F) + (5-L^H) + (6-S) - (7) + (8) - (9) - (10)$

Unlike the first approximation MC to net aggregate consumption benefits, DR^M does not have to be corrected for the social opportunity costs of foreign exchange, unskilled labour, and investment vis-à-vis consumption. What is an opportunity cost with respect to the aggregate consumption of the whole nation is not necessarily an opportunity cost for a particular region. Thus, although Galivia as a whole foregoes benefits equal to the opportunity cost of foreign exchange when imported inputs are used in the Panagua Project, the loss of benefits to the Mendalvan farmer when he pays for imported fertilizers is simply the market cost which he gives up. The loss due to the extra social value of the foreign exchange used is spread over the whole country, and its effect on Mendalva can be regarded as negligible. For similar reasons, the benefits to Mendalva of employing unskilled labour are not limited to the excess of the market wage over the amount actually necessary to attract the labour; the latter represents a cost to the nation as a whole, but not to the Mendalvan region. Finally, if investment is valued higher than the equivalent current consumption in calculating aggregate consumption benefits, this is because the increased consumption flow provided by investment is a gain to the nation as a whole. The fraction of the gain which reaches Mendalva may for practical purposes be ignored.

There does remain, however, one important adjustment of DR^M which must be made to assess the total net consumption benefits distributed to Mendalva by the Project. Whether the direct benefits measured by DR^M are consumed or invested, a part of them will be respent within the Mendalvan region and – to the extent that they result in a net transfer of wage and profit earnings from elsewhere in Galivia to Mendalva, or activate otherwise idle Mendalvan resources – they will result in a new round of benefits to the region. Such a chain of

indirect benefits can in principle continue indefinitely, with the benefits on each successive round progressively declining. If γ represents the proportion of marginal benefits to Mendalvans which - when respent - results in additional benefits to the region, then the total direct and indirect value of net regional consumption benefits in a given year is given by:

[7] $\quad R^M = DR^M (1 + \gamma + \gamma 2 + \gamma 3 + \ldots\ldots\ldots)$

$\qquad = DR^M \left(\dfrac{1}{1-\gamma}\right)$

$\qquad = DR^M + \left(\dfrac{\gamma}{1-\gamma}\right) DR^M$

The expression $\left(\dfrac{\gamma}{1-\gamma}\right)$ is thus the ratio of indirect to direct regional benefits. The value of γ is another item of information that must be provided from above the project level in order to evaluate the Panagua Project. (In deriving the formula given in equation 7, the time element involved in the indirect benefits has been tacitly ignored; successive rounds are assumed to occur quickly enough so that the value of benefits in later rounds does not decrease significantly because of the passage of time.)

VI. THE GROUP REDISTRIBUTION OBJECTIVE

The third national objective to be considered in the evaluation of the
Panagua Project is the objective of redistributing benefits to small farmers.
In principle, redistribution objectives could be formulated with respect to
every group of people in the country, and different weights - positive or
negative - could be attached to the welfare of each, so as to correct for the
unweighted addition of benefits to all Galivians which is measured by the aggregate
consumption objective. In practice, however, it is only reasonable to restrict
the differentiation of benefits by groups to major cases where the Government
feels that there is an important national interest to be served by redistribution
of general welfare. Such a case in Galivia is presented by the small farmers,
whose contribution to the successful struggle for independence has brought
little economic reward in most parts of the country.

In order to evaluate the net effect of the Panagua Project on the welfare
of small farmers, it is necessary to compare their economic position before and
after the construction of the Project. As shown in Table 3 of the Project
Report, there are at present 1907 small farm units (defined as holdings of less
than 10 hectares) in the Secotuan valley area, and this number will rise to
3,579 when the Project is completed. Not all of the 3,579, however, belong to
the original class of small farmers, since some of these 10-hectare units are
to be formed by paring down larger holdings of the farmers who own land in the
irrigated area. Apart from the 1,907 small units, there are at present 173
units in excess of 10 hectares. Of these, 134 are expected to remain in excess
of 10 hectares, and the remaining 39 will be cut down to 10 hectares. Thus, of
the total of 3,579 10-hectare units to be located on the irrigated land, 1,907
will belong to the original small holders, 1,633 will belong to small farmers

relocated from the surrounding area, and 39 will belong to farmers with previously larger holdings.

According to Table 3, the 1,907 small farmers cultivate at present 42.9% of the land area to be taken over by the Project. It will be assumed that they earn likewise 42.9% of the annual net agricultural income resulting from current cultivation. No figures are available on the current earnings of the 1,633 small farmers to be relocated from adjacent areas, but it may be reasonable to assume that their holdings are so small and the land so marginal that their sacrifice of current farm income in negligible. Thus the net agricultural income foregone by small farmers because of the Project may be estimated as .429 (7), where (7) refers to the total value of net agricultural income foregone as given in Table 19.

After the Panagua Project is underway, the 3,540 small farmers will hold 35,400 of the 40,000 cultivatedhhectares, or 88.5% of the total cultivated area. As before, it may be assumed that they receive the same percentage of the total market value of agricultural production and incur the same percentage of cultivating costs, so that their net farm earnings amount to .885 [(1) - (5) - (9) - (10)]. The same percentage of imputed family wages also accrues to the small farmers as a group: .885 $(5-L^F)$. With respect to the housing and social service benefits (2), it is more appropriate to assume that they will be enjoyed by small farmers according to their fraction in numbers rather than in acreage. Thus the relevant value of benefits becomes 3540/3713 (2) = .954 (2). Finally, it is clear that the gains from land compensation (8) go to large rather than small farmers, and must not be included among small farmer benefits.

The total value of net consumption benefits provided by the Panagua

Project to small farmers can now be expressed as

[8] $R^{SF} = .865 [(1) - (5) + (5-L^F) - (9) - (10)] + .954 (2) - .429 (7)$

For reasons analogous to those given in analyzing the regional redistribution

benefits, there is no need to correct R^{SF} for the failure of market prices to

reflect social opportunity costs; such corrections are relevant only to the

aggregate consumption objective. In the case of small farmer benefits, there

is also no reason to consider indirect benefits of the kind included with the

calculation of regional benefits, since the expenditures of small farmers are

very unlikely to return additional benefits in successive rounds of spending.

VII. THE EVALUATION OF THE PROJECT

In the course of the three previous Parts IV, V and VI, dealing with the
three principal objectives of the Galivian Government vis-à-vis the Panagua
Project, a variety of parameters were defined for which values are required
to evaluate the Project. In principle, each of these parameters is a function
of time, and the appropriate values may therefore change according to the year
in which the benefits and costs are being measured. To simplify the computations,
however, it will be assumed for the purposes of illustration that the value
of each parameter remains constant over the entire lifetime of the Project.
In the accompanying Table 20, each parameter is listed with the corresponding
numerical value that is assumed to be appropriate to the Galivian economy and
- where applicable - to the circumstances of the Panagua Project.

Foreign exchange is assumed to be worth twice its value at the official
exchange rate (φ = +1.0). Given the rural setting of the Panagua Project,
the nature of the work - farming and construction - and the relative over-
population and backwardness of the Mendalvan region, it may not be unreasonable
to regard the opportunity cost of unskilled labor as equal to zero (λ = -1.0).
In contrast, the opportunity cost of agricultural extension workers is assumed
to be twice the market wage (λ^E = +1.0).

The social rate of discount used by the Galivian Government, which is
meant to reflect the collective preference of the nation for present over
future consumption, is assumed to be 10% (i = 0.10). Given a marginal rate of
return of 15% on private sector investment (γ = 0.15) and a rate of re-investment
of profits of 50% (μ = 0.50), the social value of investment relative to
consumption can be derived from equation 3. It turns out that investment
brings future consumption benefits worth three times present consumption ($\bar{p}$ = 3).

As for propensities to save (resulting in investment), farmers are assumed to consume 80% of their earnings (σ^F = 0.2), while unskilled laborers consume all of their wages (σ^L = 0.0). The Galivian Government - in view of the high value of investment - is ready to devote all available funds to that purpose (σ^G = 1.0). The marginal propensity to save of the taxed public depends on who pays for marginal increases in taxation. It is likely that corporations and high income brackets will be most affected, so that the corresponding marginal propensity to save is very high (σ^T = 0.8). Finally, the marginal propensity to respend within Mendalva is assumed to be 20% (γ = 0.2).

Given the values of the parameters 1 to 9 in Table 20. and given all of the relevant flows over time in Table 19, it is now possible to calculate the contributions made by the Panapua Project to each of the three objectives, in each year of the Project, by substituting into the appropriate equations derived in Parts 1V, V and VI. In order to calculate the total contribution to each objective, all that is needed in addition is a set of weights to put the contributions in different years on a comparable basis. Again, in the interest of simplifying the calculations, it will be assumed that the rate of discount applied to each objective is constant over time, and that these three rates of discount are equal to one another and therefore equal to the social rate of discount i (which is defined as the rate of discount applied to the aggregate consumption objective).

Since all the relevant parameters are assumed to be constant, it is not necessary to make separate calculations for each year of the Project. Instead, all of the time flows in Table 19 can be converted into their equivalent present values by discounting back to year 0 at the common rate of discount of 10%; and the present values of each flow item can then be substituted into the

equations given earlier to compute the total contribution of the Project to the different objectives. Table 21 lists the present value in year 0 of each of the flows of Table 19, discounted at alternative rates of 5%, 7½% and 10%. Using the values discounted at 10%, the results are obtained as shown in Table 22.

The present value of net aggregate consumption benefits is shown in successive stages of approximation. Using market prices, the present value MC turns out to be positive but comparatively low, at a level of 39.3 million pesetas. This figure corresponds very closely to the value computed by Dr. Blancabeza in Part VII of the Project Report. Using also a 10% rate of discount, Dr. Blancabeza arrived at a figure of 35.2 million pesetas, which he labelled the net present value of the Project as a whole. The slight difference between the two figures is due to the fact that Dr. Blancabeza (incorrectly) included compensation payments to landowners - with a present value of 4.1 million pesetas - as an element of construction costs.

The second approximation SC suggests a substantially greater Project contribution to the aggregate consumption objective. The (positive) foreign exchange and extension worker premiums - applied to negative net benefits - serve to reduce the value given by MC, but the (negative) unskilled labor premium - applied to the total market wage bill of unskilled labor - raises the value of net benefits by a much greater amount. The 284.3 million pesetas originally charged to the Project as unskilled labor costs are replaced by the corresponding social opportunity cost of zero, and SC becomes equal to 233.9 million pesetas.

The final approximation C, however, indicates that the Panagua Project actually makes a decidedly negative contribution to the aggregate consumption objective. This is due to the high social value of investment relative to consumption ($\bar{p} = 3$), and to the unfavorable overall effect of the Project on the

rate of investment elsewhere in the Galivian economy. The two groups with the highest propensity to invest - the Galivian Government and the (marginally) taxed public - suffer net losses on account of the Project. Funds raised to finance the Project carry a high opportunity cost, for they would largely have been invested on alternative projects. On the other hand, the chief beneficiaries of the Project - the farmers and unskilled laborers - tend to consume most of their benefits and add little to investment in the economy. The result is that - when all things are considered - the net aggregate consumption benefits of the Paragua Project amount to <u>minus</u> 196.4 million pesetas.

As against thi; negative contribution to aggregate consumption, the Project does make suistantially positive contributions to both redistribution objectives. The Mendalvan region and the small farmers of the Secotuan valley do not pay the high price of drawing funds away from investment elsewhere in Galivia, but they do reap most of the benefits of the Panagua investment itself. According to Table 22, the present value of net benefits - direct and indirect - to Mendalva is equal to 855.1 million pesetas, and the corresponding figure for the small farmers is 374.1 million pesetas. It is clear that on aggregate consumption grounds alone, the Panagua Project is not justified. It is worth undertaking only if the Galivian Government places a sufficient weight on redistribution of welfare to the Mendalvan region and for the small farmers so that the combined net present value of all benefits is positive.

The weights to be placed on separate objectives represent the last and most crucial set of data that must be supplied by the Central Government in order for projects to be evaluated on a consistent and meaningful basis. In order to decide whether or not to undertake the Panagua Project as it has been presented in the Project Report, the Galivian Government must quantify the importance it

attaches to objectives other than aggregate consumption. For the purposes of the analysis, it will be assumed - as indicated in Table 2J - that the Government places an extra weight of 0.25 on benefits to Mendalva, and 0.50 on benefits to small farmers, relative to the weight it gives to aggregate consumption benefits for the nation as a whole.

The net present value V of the Panagua Project with respect to all of the major national objectives is expressed - in terms of aggregate consumption - as:

$$[9] \qquad V = \theta^C C + \theta^{RM} R^M + \theta^{RSF} R^{SF}$$

Substituting in the corresponding values from Tables 20 and 22, the following result is obtained: $V = 204.4$ million pesetas

Thus the positive redistributional benefits outweigh the negative aggregate consumption benefits and - in the last analysis - the Panagua Project appears to be worth undertaking.

VIII. A FEW QUALIFICATIONS

The evaluation carried out in Part VII was designed to answer a yes-or-no question: Should the Panagua Project be undertaken or not? This approach is valid only if there are no specific variants, or mutually exclusive alternatives, to the Project as formulated in the Report. In this event, the only relevant alternative to the Project is the general alternative of investing the same funds elsewhere in the economy, and this has been taken into account in the analysis. If, however, there exists the possibility of varying or replacing the Project with an otherwise excluded alternative, it is necessary to inquire into the possibility of obtaining additional net benefits. Thus, even though the Panagua Project in its present form yields a significantly positive net present value, it should not be undertaken if it prevents the undertaking of an alternative project with an even greater overall net present value. Such a possibility might arise in a number of ways.

First of all, it might well be possible to make marginal adjustments in the method of construction or operation of the Project, or on the related agricultural production program, which would result in a higher net present value than yielded by the Project in its proposed form. Unless the engineers who designed, and the officials who formulated, the Project were continuously aware of the appropriate methods for evaluating alternative possibilities, it is more than likely that there is still scope for improvement when the Project reaches the decision-makers. To anticipate this likelihood, it would be useful for the Project to be presented not as a single package, but as a manageable array of alternatives from among which the decision-makers could choose the most favourable according to the accepted method of evaluation. In any case, it would be necessary to ask whether adjustments in the nature or scope of the Panagua Project could raise its net present value.

An additional - and potentially important - adjustment of the Project concerns neither its nature nor its scope, but its timing. If the Panagua Project is begun in 1967, this excludes the possibility of starting it at any later date. Provided all benefits and costs are dependent only on the age of the Project itself, it would clearly be worth undertaking right away or not at all - for the longer it is put off, the lower the discounted present value of the net benefits. However, if some of the benefits or costs are affected by the calendar date on which they occur, and if net benefits are expected to increase with time, then a higher present value may be realized if the Project is delayed. This alternative must also be considered when evaluating the Project.

Apart from asking about possible adjustments of the Panagua Project itself, the decision-makers must compare the Panagua Project with wholly different projects that are excluded by it. If, for example, there is an alternative use for the water resources of the Rio Casqueya, such a possibility must be explored before it is pre-empted by the Panagua Project. Similarly, if there are alternative ways of supplying the Secotuan valley with irrigation water - e.g., via a network of tube wells - this possibility must also be compared with the Panagua Project in terms of its net contribution to national objectives.

In sum, the positive net present value V of 204.4 million pesetas obtained in the evaluation of the Panagua Project indicates that there is a national gain of at least that amount to be realized by undertaking a water resource project in the Rio Casqueya - Secotuan valley area. But until all of the relevant alternatives have been explored, it cannot be concluded that the Panagua Project should be undertaken in the precise form in which it was originally proposed.

IX. ALTERING THE AGRICULTURAL PROGRAM

As stressed in Part VIII, it is important to consider various alternative possibilities before going ahead with the Panagua Project as proposed. In this part, the effect of altering the suggested agricultural program by changing the pattern of land ownership and crop distribution will be considered. The pattern of land ownership proposed in the Project Report is characterized by a vast number of small 10-hectare holdings covering almost 90% of the irrigated land, and the remaining 10% is divided among holdings no greater than 50 acres (see Table 3.) The crop distribution corresponding to this system of land tenure emphasizes diversity and self-sufficiency, and includes both low and high profit yielding crops in roughly equal measure (see Table 4).

To study the range of alternatives, it will now be hypothesized that the 40,000 hectares of newly irrigated land are divided into 400 large holdings of 100 hectares each. On such large holdings, it is presumed that a greater proportion of the land can be devoted to the cultivation of the commercially most profitable crops. Table 23 presents figures for an alternative distribution of crops based on 100-hectare holdings, consistent with the constraints imposed by the availability of irrigation water and the requirements of on-farm consumption. A comparision of Table 23 with Table 4 of the Project Report shows that the production of high-yielding tomatoes has been stepped up the most radically. More acreage is also devoted to corn, alfalfa, soybeans and vegetables, while the cultivation of low-yielding beans, sesame and wheat has been cut to a minimum.

As a result of the changes in cropping pattern, the total value of annual agricultural production is almost doubled - from 131.60 to 252.56 million pesetas - while the total annual farmer costs (exclusive of irrigation fees)

are also doubled – from 58.20 to 116.48 million pesetas – and the surplus
rises from 73.40 to 136.08 million pesetas. As before, it will be assumed
that in the initial years 5 to 10 the annual value of agricultural production
and costs rises from one half to its full level in equal linear increments.
Government supplied farm equipment and agricultural credit are assumed to rise
in the same proportion as farmer costs, but irrigation fees remain as before –
since there has been no change in the costs of construction or operation of the
Project works. It will also be assumed that only half as many extension workers
are required as before. The change in cropping pattern is much more drastic
and calls for a more intensive education in new techniques; but there are now
many fewer farmers to teach, and this allows for a considerable saving.

The evaluation of the Project in the light of the revised agricultural
program may now proceed by comparison with the earlier computations. Table 24
lists the year 0 present values, under the new assumptions, of each of the
benefit, cost and transfer flows distinguished in Table 19, discounted at alter-
native rates of 5%, $7\frac{1}{2}$% and 10%. The flows whose values differ from the
corresponding figures in Table 21 are identified by an asterisk in Table 24.
The market value of the crops (2) is raised by a factor of 1.919, while the
foreign exchange component (1-F) due to the tomato exports is raised by a
factor of 5.0 The domestic currency component (1-D) simply represents the
difference between the two. Neither the costs of construction (3) or operation
(4) of the Project works, nor the agricultural income foregone by farmers (7),
the land compensation payments (8) or the irrigation fees (9), are affected
by the changed agricultural program. All of the other items under (5), (6) and
(10) – which relate to the costs of agricultural production – are increased in
the same proportion 2.001, with the exception of the extension worker costs
(6-S) that are cut in half.

Table 25 lists the numerical results obtained under the new assumptions for the overall net present value V of the Project, the net contribution obtained with respect to each major objective C, R^M and R^{SF}, and the various approximations and component elements of C. The values with respect to the aggregate consumption and regional redistribution objectives were calculated on the basis of the formulas derived earlier in Parts IV and V. The value for R^{SF} is based on the corresponding formula 8 derived in Part VI, except that the relevant small farmer percentages of 88.5% and 95.4% are reduced to zero under the new program.

It is clear from the results that the overall net present value of the Project with the new program greatly exceeds its value as originally proposed. Thus if this alternative is really open to the Government, and if the Government stands by the relative weights it has given to the separate national objectives, then it should reformulate the agricultural program of the Project.

It is quite conceivable, however, that the Government cannot afford for political reasons to turn all of the newly irrigated farm land over to a few cultivators with 100 acres each. Among other things, this would involve the ejection of a majority of the small farmers who currently hold land in the affected area. In the interests of political realism - if not elementary social justice - the Government's interest in large farm units may have to be confined to the surplus area remaining after all of the original land holders have been provided with a share of the newly irrigated land. Under these circumstances, the following distribution of land holdings might be envisaged:

Size of holding	AREA (ha)	%	Farmers (no)	%	AVERAGE Holding (No)
less than 10 HA	19961	49.9	1907	88.5	10.5
10 to 100 Ha	8724	21.8	135	6.3	64.5
More than 100 Ha	11315	28.3	113	5.2	100.1
TOTAL	40000		2155		18.7

As can be seen by comparision with Table 3 of the Project Report, this distribution assures to all of the farmers holding less than 100 hectares of land the same area that they held prior to irrigation, and it breaks up the remaining parcels of greater than 100 hectares into equal 100 hectare units. (100 hectares may be regarded as the maximum irrigated land allowed by law to a single farming unit). Under this system of tenure, the 1997 small farmers may be assumed to cultivate their 49.9% of the level according to the cropping pattern envisaged under the first (small-unit) agricultural program, and the remaining 248 larger land-holders may be assumed to cultivate their 50.1% of the land according to the second (large-unit) agricultural program.

The effect of such a compromise on the net present value of the Project is very easy to calculate: it amounts in every respect to an almost 50-50 split between the outcomes of the two polar cases. Ignoring the minor differences due to the fact that the original program included a few medium-sized holdings in addition to the small farm units, the results can be summarized as follows (assuming the same values as before for the key parameters):

$C = + 1061.3$ million pesetas

$R^M = +1170.7$ million pesetas

$R^{SF} = + 186.0$ million pesetas

$V = + 1447.0$ million pesetas

The net present value V of the Project is now reduced to 1447 million pesetas, but it of course still exceeds the original value of 204.4 million by a substantial margin and indicates that the Government ought to revise the agricultural program insofar as possible to create large farming units. The net reduction in present value of 1242.6 million pesetas, which is caused by the need to maintain the land ownership of existing farmers with units less than 100 hectares, is a measure of the value of this politico-social constraint, and the importance which is attached to it (if it is respected) by the Galivian Government.

The Project evaluators may now say to the responsible decision-makers that - given their preferences as expressed by the relative weights which they attached to different national objectives - the Panagua Project is worth undertaking, and the surplus area contained in existing holdings of greater than 100 hectares should be distributed in large holdings of 100 hectares each, rather than in small units of 10 hectares. If, when confronted with the consequences of their own quantified preferences, the decision-makers object that they would actually prefer the small holding program, because otherwise a great number of small farmers would not be benefited, then this is an indication that the weights which they originally ennuciated do not actually reflect their desires. Under these circumstances, they would be revealing that they actually place a much higher weight on redistribution to small farmers than the original premium of 0.5.

The range of values for the weight on small farmer benefits which would justify the original rather than the alternative program may be calculated from the following equation:

$$C + 0.25 \ R^M + x \ R^{SF} = C* + 0.25 \ R^{M*} + x \ R^{SF*}$$

where C, R^M and R^{SF} refer to the net present value of benefits under the original program, the corresponding starred variables refer to the benefits under the alternative program, and x is the weight on small farmer benefits which would just cause the programs to break even. Substituting the appropriate values, we have

$$-196.4 + 213.8 + 374.1 \ (x) = 1061.3 + 292.7 + 186.0 \ (x)$$
$$188.1 \ (x) = 1336.6$$
$$(x) = 7.1$$

Thus if the Galivian Government decision-makers really prefer the small-holding to the large-holding alternative, the implication is that they attach a premium of at least 7.1 to net benefits flowing to small farmers.

PART III

TABLES

TABLE I

DISTRIBUTION OF TOTAL PROJECT CAPITAL COSTS OVER TIME
(All figures in million pesetas)

	Total	Year 1	Year 2	Year 3	Year 4
Basic Habilitation Works					
Panagua Dam	140	42	42	56	-
Main Canals	137	22	28	69	18
Distribution System	51	-	-	16	35
Drainage System	71	-	-	20	51
Roadways	10	-	-	3	7
Land Clearing	30	-	-	3	27
Social Improvement Works					
Housing for farmers	14	-	-	7	7
Basic rural utilities	14	-	-	7	7
Urban Center	12	-	5	7	-
Others					
Compensation	5	-	5	-	-
TOTAL	484	64	80	188	152

TABLE 2

PERCENTAGE DISTRIBUTION OF PROJECT CAPITAL
COSTS BY RESOURCE CATEGORY

	Mach-inery	Skilled Labor	Unskilled Labor	Cement	Iron & Steel	Other Materials
BASIC HABILITATION WORKS						
Panagua Dam	50	10	30	3	-	7
Main Canals	25	10	35	15	5	10
Distribution System	20	10	45	10	3	12
Drainage System	45	10	40	-	-	5
Roadways	35	10	35	5	2	13
Land Clearing	45	10	45	-	-	-
SOCIAL IMPROVEMENT WORKS						
Housing for farmers	-	5	65	10	-	20
Basic rural utilities	15	15	40	5	5	20
Urban center	10	10	50	5	5	20
OTHERS						
Compensation	-	-	-	-	-	-

PERCENTAGE BREAKDOWN OF MACHINERY COSTS

Depreciation on Equipment:	30%
Semi-skilled operating labor:	20%
Fuels, oils, grease, etc.:	25%
Spare parts, components, miscellaneous items:	25%

TABLE 3

DISTRIBUTION OF LAND HOLDINGS IN THE PROJECT REGION

Size of Holding	Area (Ha)	%	Farmers (no.)	%	Average Holding (Ha)
NOW					
Less than 10 ha.	19,961	42.9	1,907	91.7	10.5
10 to 100 ha.	8,724	18.8	135	6.5	64.5
More than 100 ha.	17,791	38.3	38	1.8	468.0
TOTAL	46,476		2,080		22.3
WITH PROJECT					
10 ha.	35,790	89.5	3,579	96.4	10.0
10 to 50 ha.	4,210	10.5	134	3.6	31.4
TOTAL	40,000		3,713		10.8

TABLE 4

PRESENT AND FUTURE CROP DISTRIBUTION AND PRODUCTION

Crop	(1) Area (Ha.)	(2) Yield (Ton/Ha.)	(3)=(1).(2) Production (Ton)	(4) Price (Ps/Ton)	(5)=(3).(4) Value of Production (Ps 10³)	(6)=(5)/(1) Unit Value of Production (Ps/Ha.)
PRESENT						
Beans	300	0.72	216	910	196	657
Corn	600	1.27	762	600	456	762
Sesame	400	0.60	240	1,270	305	763
Sorghum	150	1.62	243	380	93	620
TOTAL	1,450				1,050	726
FUTURE						
Beans	2,000	1.32	2,640	1,310	3,460	1,730
Corn	4,000	3.30	13,200	780	10,300	2,580
Sesame	4,000	1.10	4,400	1,450	6,400	1,600
Sorghum	3,000	3.53	10,590	540	5,720	1,910
Alfalfa	4,000	11.00	44,000	330	14,520	3,630
Safflower	3,000	2.20	6,600	940	6,200	2,070
Soybeans	9,000	2.20	19,800	1,370	27,140	3,010
Tomatoes	2,000	11.00	22,000	1,450[*]	32,000	16,000
Vegetables	2,000				7,400	3,700
Wheat	4,000	3.30	13,200	580	7,660	1,920
Other crops	3,000				10,800	3,600
TOTAL	40,000				131,600	3,290

[*]Official Peseta Equivalent of Dollar Export Price

TABLE 5

PRESENT AND FUTURE FARMER COSTS OF CULTIVATION

Crop	(1) Area	(2) Unit Cost (Ps/Ha.)	(3)=(1).(2) Cost (Ps 10^3)	(4) Value of Produce (Ps 10^3)	(5)=(4)-(3) Surplus (Ps 10^3)	(6)=(5)/(1) Unit Surplus (Ps/Ha.)
PRESENT						
Beans	300	285	85	196	112	374
Corn	600	268	160	456	298	497
Sesame	400	237	95	305	211	522
Sorghum	150	196	30	93	64	427
TOTAL	1,450	256	370	1,050	680	470
FUTURE						
Beans	2,000	1,250	2,500	3,460	960	480
Corn	4,000	800	3,200	1,030	7,100	1,780
Sesame	4,000	1,040	4,160	6,400	2,240	560
Sorghum	3,000	730	2,190	5,720	3,530	1,180
Alfalfa	4,000	1,870	7,480	14,520	7,040	1,760
Safflower	3,000	890	2,670	6,200	3,530	1,180
Soybeans	9,000	1,040	9,360	2,714	1,778	1,970
Tomatoes	2,000	8,000	16,000	32,000	16,000	8,000
Vegetables	2,000	1,600	3,200	7,400	4,200	2,100
Wheat	4,000	960	3,840	7,660	3,820	960
Other annual crop	3,000	1,200	3,600	10,800	7,200	2,400
TOTAL	40,000	1,450	58,200	131,600	73,400	1,840

TABLE 6

AVERAGE PERCENTAGE BREAKDOWN OF FUTURE
FARMER COSTS OF CULTIVATION

1.	Family (unskilled) labor	30%
2.	Hired labor	10%
3.	Machinery and equipment and spare parts	15%*
4.	Fuel and grease requirements for machinery	5%
5.	Chemical fertilizers	18%
6.	Pesticides, fungicides, etc.	5%
7.	Seeds	5%
8.	Animal labor (fodder)	10%
9.	Interest on credit	2%**
		100%

*Charges for rental paid to Ministry of Agriculture

**Charges for credit paid to Ministry of Agriculture

TABLE 7

PROJECT ANNUAL OPERATING COSTS

Total cost	Ps. 4.0	million/year
of which		
Skilled labor	20%	
Unskilled labor	40%	
Machinery*	15%	
Cement	7.5%	
Other materials	17.5%	

(*% breakdown same as shown in Table 2)

Table 8
MINISTRY OF AGRICULTURE PROGRAMME COSTS
(all figures in million pesetas)

Years	Total	Farm Machinery and Equipment	Agricultural Credit	Agricultural Extension Service
5	40.5	30.0	7.5	3.0
6	10.5	6.0	1.5	3.0
7	10.5	6.0	1.5	3.0
8	10.5	6.0	1.5	3.0
9	10.5	6.0	1.5	3.0
1C	10.5	6.0	1.5	3.0
11-54	6.6	6.0	-	0.6

Table 9

MENDALVAN WATER AUTHORITY ACCOUNT

(all figures in million pesetas)

Years:	1	2	3	4	.5-24	25-34	35-54
PAYMENTS							
Construction costs	64.0	80.0	188.0	152.0	-	-	-
Operating costs	-	-	-	-	4.0	4.0	4.0
World Bank loan	-	-	-	-	13.5	-	-
Treasury loan	-	-	-	-	22.2	22.2	-
TOTAL	64.0	80.0	188.0	152.0	39.7	26.2	4.0
RECEIPTS							
World Bank loan	22.3	24.5	54.0	42.4	-	-	-
Treasury loan	41.7	55.5	134.0	109.6	-	-	-
Irrigation Fees	-	-	-	-	20.0	20.0	20.0
TOTAL	64.0	80.0	188.0	152.0	20.0	20.0	20.0
NET CASH INFLOW	-	-	-	-	-17.7	-6.2	+16.0

Table 10

MINISTRY OF AGRICULTURE ACCOUNT

(all figures in million pesetas)

YEARS:		5	6	7	8	9	10	11-54
PAYMENTS								
Farm Equipment		30.00	6.00	6.00	6.00	6.00	6.00	6.00
Working Capital		7.50	1.50	1.50	1.50	1.50	1.50	-
Extension Workers		3.00	3.00	3.00	3.00	3.00	3.00	0.60
	TOTAL	40.50	10.50	10.50	10.50	10.50	10.50	6.60
RECEIPTS								
Rental & interest on Equipment		4.36	5.23	6.10	6.97	7.85	8.73	8.73
Interest on Credit		0.58	0.70	0.81	0.93	1.04	1.16	1.16
	TOTAL	4.94	5.93	6.91	7.90	8.89	9.89	9.89
NET CASH INFLOW		-35.56	-4.57	-3.59	-2.60	-1.61	-0.61	+3.29

Table 11

FARMER ACCOUNT

(all figures in million pesetas)

YEARS:	5	6	7	8	9	10-54
PAYMENTS						
Irrigation Fees	20.00	20.00	20.00	20.00	20.00	20.00
Rental & Interest on Equipment	4.36	5.23	6.10	6.97	7.85	8.73
Interest on Credit	0.58	0.70	0.81	0.93	1.04	1.16
Other Cultivation Costs	24.16	28.99	33.83	38.66	43.49	48.31
TOTAL	49.10	54.92	60.74	66.56	72.38	78.20
RECEIPTS						
Value of Agr. Production	65.80	78.96	92.12	105.28	118.44	131.60
NET CASH INFLOW	16.70	24.04	31.38	38.72	46.06	53.40

Table 12

SUMMARY OF BENEFITS AND COSTS (A)

(all figures in million pesetas)

YEARS:	5	6	7	8	9	10-24	25-34	35-54
BENEFITS								
Farmer Surplus with Project	36.70	44.04	51.38	58.72	66.06	73.40	73.40	73.40
Farmer Surplus without Project (-)	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68
TOTAL	36.02	43.36	50.70	58.04	65.38	72.76	72.76	72.76
COSTS								
World Bank Loan Repayment	13.50	13.50	13.50	13.50	13.50	13.50	—	—
Treasury Loan Repayment	22.20	22.20	22.20	22.20	22.20	22.20	22.20	—
Operating Costs	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
TOTAL	41.70	41.70	41.70	41.70	41.70	41.70	26.20	4.00
TOTAL BENEFITS MINUS COSTS	-5.68	+1.66	+9.00	+16.34	+23.68	+31.06	+46.56	+68.76

Table 13

SUMMARY OF BENEFITS AND COSTS (B)

(all figures in million pesetas)

YEARS	1	2	3	4	5	6	7	8	9	10	11-54
BENEFITS											
Farmer Surplus with Project	-	-	-	-	36.70	44.04	51.38	58.72	66.06	73.40	73.40
Farmer Surplus without Project (-)	-	-	-	-	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68
Housing & Social Services	-	-	-	-	2.80	2.80	2.80	2.80	2.80	2.80	2.80
TOTAL	-	-	-	-	38.82	46.16	53.50	60.84	68.18	75.56	75.56
COSTS											
Construction of Project Works	64.00	80.00	188.00	152.00	-	-	-	-	-	-	-
Operation of Project works	-	-	-	-	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Agricultural assistance	-	-	-	-	40.50	10.50	10.50	10.50	10.50	10.50	6.60
Net of Farmer Payments (-)	-	-	-	-	-4.94	-5.93	-6.91	-7.90	-8.89	-9.89	-9.89
TOTAL	64.00	80.00	188.00	152.00	39.56	8.57	7.59	6.60	5.61	4.61	0.71
TOTAL BENEFITS MINUS COSTS	-64.00	-80.00	-188.00	-152.00	-0.74	+37.59	+45.91	+54.24	+62.57	+70.95	+74.85

Table 14

CONSTRUCTION COSTS BY YEAR AND INPUT CATEGORY

(all figures in million pesetes)

YEARS:	1	2	3	4	TOTAL
INPUTS					
Machinery	26.5	28.5	61.6	50.1	166.7
Depreciation	8.0	8.6	18.5	15.0	50.1
Labour	5.3	5.7	12.3	10.1	33.4
Fuel	6.6	7.1	15.4	12.5	41.6
Parts	6.6	7.1	15.4	12.5	41.6
Skilled Labour	6.4	7.5	18.8	15.2	47.9
Unskilled Labour	20.3	24.9	69.4	64.4	179.0
Cement	4.5	5.7	15.2	7.6	33.0
Iron and Steel	1.1	1.7	4.7	2.4	9.9
Other Materials	5.2	6.7	18.3	12.3	42.5
Compensation for Land	-	5.0	-	-	5.0
TOTAL	64.0	80.0	188.0	152.0	484.0
RESOURCE USE					
Unskilled Labour	20.3	24.9	69.4	64.4	179.0
Skilled Labour	11.7	13.2	31.1	25.3	81.3
Domestic Materials	9.7	12.4	33.5	19.9	75.5
Foreign Exchange	22.3	24.5	54.0	42.4	143.2
CASH TRANSFERS					
Compensation to Landowners	-	5.0	-	-	5.0

Table 15

OPERATING COSTS BY YEAR AND INPUT CATEGORY

(all figures in million pesetas)

YEARS:	5 ⟶ 54
INPUTS	
Machinery	0.60
Depreciation	0.18
Labour	0.12
Fuel	0.15
Parts	0.15
Skilled Labour	0.80
Unskilled Labour	1.60
Cement	0.30
Other Materials	0.70
TOTAL	4.00

RESOURCE USE	
Unskilled Labour	1.60
Skilled Labour	0.92
Domestic Materials	1.00
Foreign Exchange	0.48

Table 16

FARMER CULTIVATION COSTS BY YEAR AND INPUT CATEGORY

(all figures in million pesetas)

YEARS	5	6	7	8	9	10-54
INPUTS						
Cultivating Labour	11.64	13.97	16.30	18.63	20.95	23.28
of Family	8.73	10.48	12.22	13.97	15.71	17.46
which Hired	2.91	3.49	4.08	4.66	5.24	5.82
Animal Labour (Fodder)	2.91	3.49	4.08	4.66	5.24	5.82
Seeds	1.46	1.75	2.04	2.33	2.62	2.91
Chemical Fertilizers	5.24	6.29	7.34	8.38	9.44	10.48
Pesticides, etc.	1.46	1.75	2.04	2.33	2.62	2.91
Fuel and Grease	1.45	1.74	2.03	2.33	2.62	2.91
Equipment and Parts	4.36	5.23	6.10	6.97	7.85	8.73
Agricultural Credit	0.58	0.70	0.81	0.93	1.04	1.16
Irrigation Water	20.00	20.00	20.00	20.00	20.00	20.00
TOTAL	40.10	54.92	60.74	66.56	72.38	78.20
RESOURCE USE						
Unskilled Labour	11.64	13.97	16.30	18.63	20.95	23.28
Domestic Materials	4.37	5.24	6.12	6.99	7.86	8.73
Foreign Exchange	8.15	9.78	11.41	13.04	14.68	16.30
CASH TRANSFERS						
Rental & Interest Payments	4.94	5.93	6.91	7.90	8.89	9.89
Irrigation Fees	20.00	20.00	20.00	20.00	20.00	20.00

Table 17

MINISTRY OF AGRICULTURE COSTS BY YEAR AND INPUT CATEGORY

(all figures in million pesetas)

YEARS:	5	6	7	8	9	10	11-54
INPUTS							
Equipment & Parts	30.0	6.0	6.0	6.0	6.0	6.0	6.0
Working Capital	7.5	1.5	1.5	1.5	1.5	1.5	-
Extension Workers	3.0	3.0	3.0	3.0	3.0	3.0	0.6
TOTAL	40.5	10.5	10.5	10.5	10.5	10.5	6.6
RESOURCE USE							
Skilled Labour	3.0	0.6	0.6	0.6	0.6	0.6	0.6
Domestic Materials	7.5	1.5	1.5	1.5	1.5	1.5	-
Foreign Exchange	30.0	6.0	6.0	6.0	6.0	6.0	6.0

Table 18

PROJECT BENEFITS BY YEAR AND OUTPUT CATEGORY

(all figures in million pesetas)

YEARS:	5	6	7	8	9	10-54
AGRICULTURAL OUTPUT						
Beans	1.73	2.08	2.42	2.77	3.11	3.46
Corn	5.15	6.18	7.21	8.24	9.27	10.30
Sesame	3.20	3.84	4.48	5.12	5.76	6.40
Sorghum	2.86	3.43	4.00	4.58	5.15	5.72
Alfalfa	7.26	8.71	10.16	11.62	13.07	14.52
Safflower	3.10	3.72	4.34	4.96	5.58	6.20
Soybeans	13.57	16.28	19.00	21.71	24.43	27.14
Tomatoes	16.00	19.20	22.40	25.60	28.80	32.00
Vegetables	3.70	4.44	5.18	5.92	6.66	7.40
Wheat	3.83	4.60	5.36	6.13	6.89	7.66
Other Crops	5.40	6.48	7.56	8.64	9.72	10.80
TOTAL	65.80	78.96	92.12	105.28	118.44	131.60
HOUSING AND SOCIAL SERVICES	2.80	2.80	2.80	2.80	2.80	2.80
AGRICULTURAL INCOME FOREGONE	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68
RESOURCES						
Domestic Earnings	49.80	59.76	69.72	79.68	89.64	99.60
Foreign Exchange	16.00	19.20	22.40	25.60	28.80	32.00
Non-Market	2.80	2.80	2.80	2.80	2.80	2.80
Domestic Losses	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68

Table 19

DOMESTIC COST AND TRANSFER FLOWS BY YEAR

(all figures in million pesetas)

MARKET VALUES											
	1	2	3	4	5	6	7	8	9	10	11-54
(1) AGRICULTURAL OUTPUT	–	–	–	–	65.80	78.96	92.12	105.28	116.44	131.60	131.60
(1-D) Domestic Currency	–	–	–	–	49.30	59.76	69.72	79.68	89.64	99.60	99.60
(1-F) Foreign Exchange	–	–	–	–	16.00	19.20	22.40	25.60	28.80	32.00	32.00
(2) HOUSING AND SOCIAL SERVICES	–	–	–	–	2.80	2.80	2.80	2.80	2.80	2.80	2.80
(3) CONSTRUCTION INPUTS	64.00	75.00	180.00	152.00	–	–	–	–	–	–	–
(3-L) Unskilled Labour	26.30	24.90	69.40	64.40	–	–	–	–	–	–	–
(3-S) Skilled Labour	11.70	13.20	31.10	25.30	–	–	–	–	–	–	–
(3-D) Domestic Materials	9.70	12.40	33.50	19.90	–	–	–	–	–	–	–
(3-F) Foreign Exchange	22.30	24.50	54.00	42.40	–	–	–	–	–	–	–
(4) OPERATING INPUTS	–	–	–	–	4.00	4.00	4.00	4.00	4.00	4.00	4.00
(4-L) Unskilled Labour	–	–	–	–	1.60	1.60	1.60	1.60	1.60	1.60	1.60
(4-S) Skilled Labour	–	–	–	–	0.92	0.92	0.92	0.92	0.92	0.92	0.92
(4-D) Domestic Materials	–	–	–	–	1.00	1.00	1.00	1.00	1.00	1.00	1.00
(4-F) Foreign Exchange	–	–	–	–	0.48	0.48	0.48	0.48	0.48	0.48	0.48
(5) FARMER AGRICULTURAL INPUTS	–	–	–	–	24.16	28.99	33.73	38.66	43.49	48.31	48.31
(5-LF) Family (Unskilled) Labour	–	–	–	–	8.73	10.48	12.22	13.97	15.71	17.46	17.46
(5-LH) Hired (Unskilled) Labour	–	–	–	–	2.91	3.49	4.08	4.66	5.24	5.82	5.82
(5-D) Domestic Materials	–	–	–	–	4.37	5.24	6.12	6.99	7.86	8.73	8.73
(5-F) Foreign Exchange	–	–	–	–	5.15	9.78	11.41	13.04	14.68	16.30	16.30
(6) MINISTRY AGRICULTURAL INPUTS	–	–	–	–	40.50	10.50	10.50	10.50	10.50	10.50	6.60
(6-S) Extension Workers	–	–	–	–	3.00	3.00	3.00	3.00	3.00	3.00	0.60
(6-D) Working Capital	–	–	–	–	7.50	1.50	1.50	1.50	1.50	1.50	–
(6-F) Foreign Exchange	–	–	–	–	30.00	6.00	6.00	6.00	6.00	6.00	6.00
(7) AGRICULTURAL INCOME FOREGONE	–	–	–	–	0.68	0.68	0.68	0.68	0.68	0.68	0.68
(8) COMPENSATION TO LANDOWNERS	–	5.00	–	–	–	–	–	–	–	–	–
(9) IRRIGATION FEES	–	–	–	–	20.00	20.00	20.00	20.00	20.00	20.00	20.00
(10) RENTAL AND INTEREST PAYMENTS	–	–	–	–	4.94	5.93	6.91	7.90	8.89	9.89	9.89

Years

COSTS

TRANSFERS

83.

Table 20

VALUES OF GENERAL PARAMETERS

1. Foreign exchange premium $\varphi = +1.0$

2. Unskilled labour premium $\lambda = -1.0$

3. Extension worker premium $\lambda^E = +1.0$

4. Marginal rate of return on investment in **private sector** $f = 0.15$

5. Social rate of discount $i = 0.10$

6. Marginal rate of re-investment of profits $\mu\nu = 0.50$

7. Social price of investment $\bar{p} = 3.0$

8. Marginal propensities to save

  a) Farmers $\sigma^F = 0.2$

  b) Unskilled Labourers $\sigma^L = 0.0$

  c) Government $\sigma^G = 1.0$

  d) Taxed Public $\sigma^T = 0.8$

9. Marginal propensity to (re-) spend in Mendalva $\gamma = 0.2$

10. Rates of discount on different objectives

  a) Aggregate Consumption $i^C = 0.10$

  b) Redistribution to Mendalva $i^{RM} = 0.10$

  c) Redistribution to small farmers $i^{RSF} = 0.10$

11. Weights on different objectives

  a) Aggregate Consumption $\theta^C = 1.00$

  b) Redistribution to Mendalva $\theta^{RM} = 0.25$

  c) Redistribution to small farmers $\theta^{RSF} = 0.50$

Table 21

PRESENT VALUE OF FLOWS IN YEAR 0

(all figures in million pesetas)

		Discount Rate:	5%	7 1/2%	10%
(1)	AGRICULTURAL OUTPUT		1,829.0	1,152.0	782.0
(1-D)	Domestic Currency		1,384.0	871.5	591.8
(1-F)	Foreign Exchange		445.0	280.5	190.2
(2)	HOUSING AND SOCIAL SERVICES		42.1	27.2	19.0
(3)	CONSTRUCTION INPUTS		416.2	389.7	365.2
(3-L)	Unskilled Labour		154.9	144.5	135.2
(3-S)	Skilled Labour		70.7	66.4	62.3
(3-D)	Domestic Materials		.65.9	61.6	57.6
(3-F)	Foreign Exchange		124.7	117.2	110.1
(4)	OPERATING INPUTS		60.1	38.8	27.1
(4-L)	Unskilled Labour		24.1	15.5	10.8
(4-S)	Skilled Labour		13.8	8.9	6.2
(4-D)	Domestic Materials		15.0	9.7	6.8
(4-F)	Foreign Exchange		7.2	4.7	3.3
(5)	FARMER AGRICULTURAL INPUTS		671.4	423.6	286.9
$(5-L^F)$	Family (Unskilled) Labour		242.6	153.0	103.7
$(5-L^H)$	Hired (Unskilled) Labour		80.9	51.0	34.6
(5-D)	Domestic Materials		121.4	76.6	51.8
(5-F)	Foreign Exchange		226.5	143.0	96.8
(6)	MINISTRY AGRICULTURAL INPUTS		141.5	101.8	77.9
(6-S)	Extension Workers		18.1	14.3	11.9
(6-D)	Working Capital		10.9	9.5	8.2
(6-F)	Foreign Exchange		112.5	78.0	57.8
(7)	AGRICULTURAL INCOME FOREGONE		10.2	6.6	4.6
(8)	COMPENSATION TO LANDOWNERS		4.5	4.3	4.1
(9)	IRRIGATION FEES		300.5	194.2	135.4
(10)	RENTAL AND INTEREST PAYMENTS		137.5	86.7	58.8

Table 22

NET BENEFITS OF THE PANAGUA PROJECT

(all figures in million pesetas)

ITEM	EQUATION NUMBER	PRESENT VALUE IN YEAR 0
AGGREGATE CONSUMPTION		
MC	(1)	+ 39.3
F	(2a)	− 77.8
L	(2b)	− 284.3
E	(2c)	− 11.9
SC	(2)	+ 233.9
SC^F	(4a)	+ 399.3
SC^L	(4b)	+ 180.6
SC^G	(4c)	− 90.9
SC^T	(4d)	− 255.1
C	(5)	− 196.4
REDISTRIBUTION TO MENDALVA		
R^M	(7)	+ 855.1
REDISTRIBUTION TO SMALL FARMERS		
R^{SF}	(8)	+ 374.1

Table 23

ALTERNATIVE CROP DISTRIBUTION FOR LARGE HOLDINGS COSTS AND VALUE OF PRODUCTION

CROPS	(1) AREA (Ha)	(2) UNIT VALUE OF PRODUCTION (Ps/Ha)	(3)=(1)(2) VALUE OF PRODUCTION (Ps.10³)	(4) UNIT COST (Ps./Ha)	(5)=(1)(4) COST (Ps.10³)	(6) UNIT SURPLUS (Ps./Ha)	(7)=(1)(6) SURPLUS (Ps.10³)
Beans	1,500	1,730	870	1,250	630	480	240
Corn	5,000	2,580	12,900	800	4,000	1,780	8,900
Sesame	-	1,600	-	1,040	-	560	-
Sorghum	1,000	1,910	1,910	730	730	1,180	1,180
Alfalfa	5,000	3,630	18,150	1,870	9,350	1,760	8,800
Safflower	1,000	2,070	2,070	890	890	1,180	1,180
Soybeans	10,000	3,010	30,100	1,040	10,400	1,970	19,700
Tomatoes	10,000	16,000	160,000	8,000	80,000	8,000	80,000
Vegetables	4,000	3,700	14,800	1,600	6,400	2,100	8,400
Wheat	500	1,920	960	960	480	960	480
Other Crops	3,000	3,600	10,800	1,200	3,600	2,400	7,200
TOTAL (B)	40,000	6,310	252,560	2,910	116,480	3,400	136,080
PREVIOUS TOTAL (A)	40,000	3,290	131,600	1,450	58,200	1,840	73,400
RATIO (B) / (A)	1,000	1,919	1,919	2,001	2,001	1,854	1,854

TABLE 24

PRESENT VALUE OF LOWS IN YEAR O
UNDER ALTERNATIVE AGRICULTURAL PROGRAM
(all figures in million pesetas)

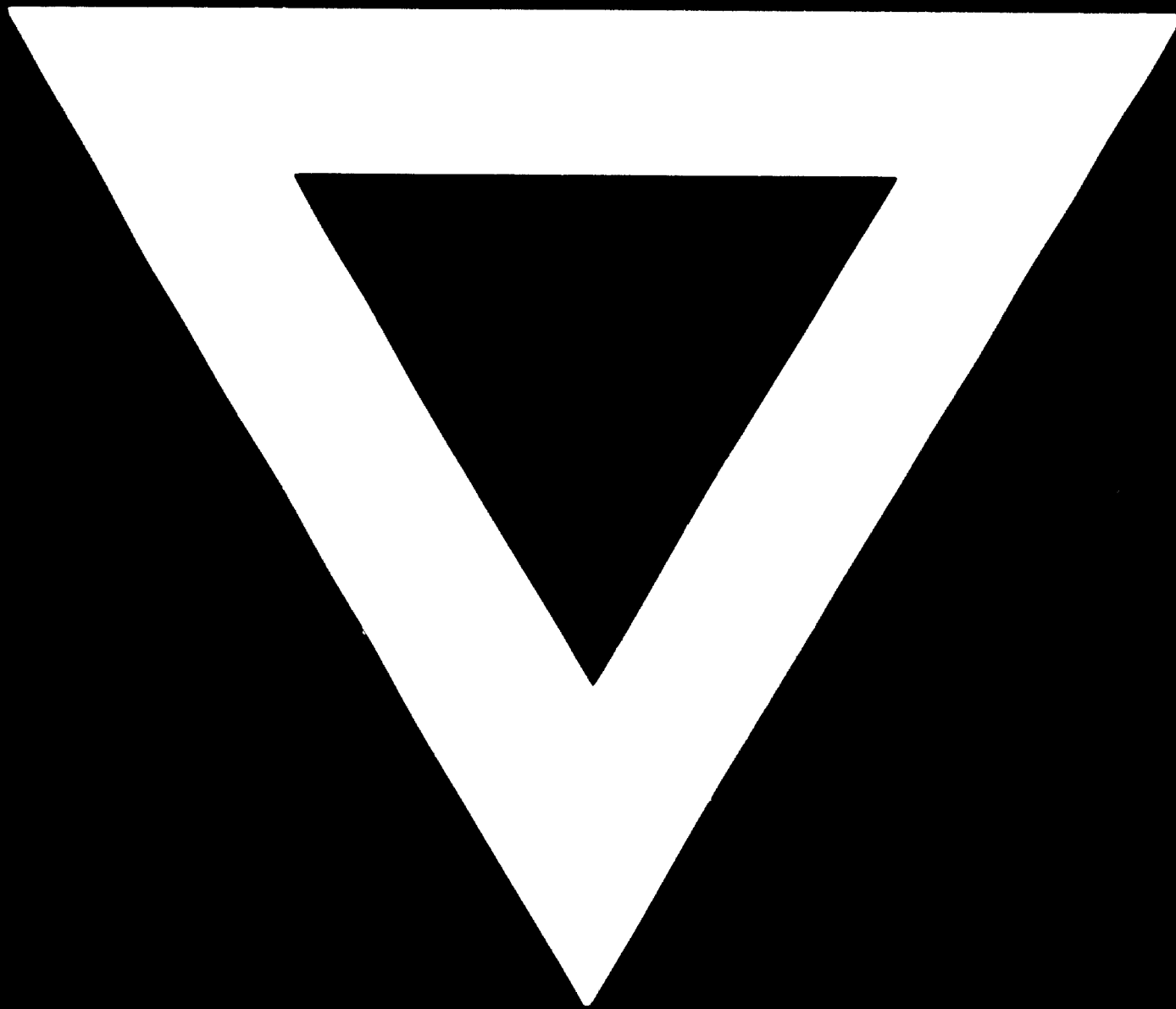|	Discount Rate: 5%	7-1/2%	10%
(1)* AGRICULTURAL OUTPUT	3,509.9	2,210.7	1,500.7
(1-D)* Domestic Currency	1,284.9	808.2	549.7
(1-F)* Foreign Exchange	2,225.0	1,402.5	951.0
(2) HOUSING AND SOCIAL SERVICES	42.1	27.2	19.0
(3) CONSTRUCTION INPUTS	416.2	389.7	365.2
(3-L) Unskilled Labor	154.9	144.5	135.2
(3-S) Skilled Labor	70.7	66.4	62.3
(3-D) Domestic Materials	65.9	61.6	57.6
(3-F) Foreign Exchange	124.7	117.2	110.1
(4) OPERATING INPUTS	60.1	38.8	27.1
(4-L) Unskilled Labor	24.1	15.5	10.8
(4-S) Skilled Labor	13.8	8.9	6.2
(4-D) Domestic materials	15.0	9.7	6.8
(4-F) Foreign Exchange	7.2	4.7	3.3
(5)* FARMER AGRICULTURAL INPUTS	1,343.5	847.6	574.1
(5-L)* Family (Unskilled) Labor	485.5	306.1	207.5
(5-L^H)* Hired (Unskilled) Labor	161.9	102.0	69.2
(5-D)* Domestic Materials	242.9	153.3	103.7
(5-F)* Foreign Exchange	453.2	286.2	193.7
(6)* MINISTRY AGRICULTURAL INPUTS	256.0	182.1	137.9
(6-S)* Extension Workers	9.1	7.1	5.9
(6-D)* Working Capital	21.8	19.0	16.4
(6-F)* Foreign Exchange	225.1	156.0	115.6
(7) AGRICULTURAL INCOME FOREGONE	10.2	6.6	4.6
(8) COMPENSATION TO LANDOWNERS	4.5	4.3	4.1
(9) IRRIGATION FEES	300.5	194.2	135.4
(10)* RENTAL AND INTEREST PAYMENTS	275.1	173.5	117.7

Table 25

NET BENEFITS OF THE PANAGUA PROJECT UNDER ALTERNATIVE
AGRICULTURAL PROGRAM

(all figures in million pesetas)

ITEM	PRESENT VALUE IN YEAR 0		
	ORIGINAL PROGRAM	NEW PROGRAM	NET CHANGE
AGGREGATE CONSUMTION			
MC	$+$ 39.3	$+$ 410.8	$+$ 371.5
F	$-$ 77.8	$+$ 528.3	$+$ 606.1
L	$-$ 284.3	$-$ 422.7	$-$ 138.4
M	$-$ 11.9	$-$ 5.9	$+$ 6.0
SC	$+$ 233.9	$+$1,355.9	$+$1,122.0
SC^F	$+$ 399.3	$+$ 887.7	$+$ 488.4
SC^L	$+$ 180.6	$+$ 215.2	$+$ 34.6
SC^G	$-$ 90.9	$+$ 508.1	$+$ 599.0
SC^T	$-$ 255.1	$-$ 255.1	$+$ 0.0
C	$-$ 196.4	$+$2,319.0	$+$2,515.4
REDISTRIBUTION TO MANDALVA			
R^M	$+$ 855.1	$+$1,486.3	$+$ 631.2
REDISTRIBUTION TO SMALL FARMERS			
R^{SF}	$+$ 374.1	$-$ 2.0	$-$ 376.1
OVERALL NET BENEFITS			
V	$+$ 204.4	$+$2,689.6	$+$2,485.2

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