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AGRICULTURAL SECTORAL ANALYSIS FOR EL SALVADOR

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TO EL SALVADOR

by

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A sectoral analysis evaluating the supply and demand factors influencing agricultural production and establishing production targets and a development strategy for the period 1970-1990.

CONTENTS

Page

Page

VII. PROGRAMS, PROJECTS, AND PRIORITIES

The foregoing chapters have (1) analyzed development problems within the agricultural sector of El Salvador's economy, (2) suggested production goals for the two decades between 1970 and 1990, and (3) noted much that needs to be done if these goals are to be attained. The purpose of this chapter, after some brief introductory remarks to clarify the use of certain terms and concepts, will be to summarize the status of various programs and projects involved in achieving the goals.

The Public Supporting Role

Major public efforts and inputs of public resources will surely be required to permit achievement of the suggested goals. Nevertheless, the final results will still depend upon the production and marketing decisions and activities of the farmers, traders, processors, retailers, and others engaged in private enterprise related to the agricultural sector. Hence, we must keep in mind that public agencies will ordinarily seek to achieve their ultimate objectives through the indirect process of engaging in programs and projects which facilitate and support the activities of private entrepreneurs.

Public agencies need to perform their supporting role through two distinct kinds of activities: first, to use public authority to maintain a favorable institutional and economic environment; second, to allocate available public resources so as to provide needed facilities, services, and credit which would otherwise be unavailable to individual business units. Given the scarcity of public resources, great selectivity must be

exercised in making the allocative kinds of decisions, but the use of public authority in developing and maintaining a favorable institutional environment is no less important. Modern livestock slaughter plants, for example, may be urgently needed in several of El Salvador's principal cities, but investment in such plants will be of dubious value if existing legislation and regulations can be used to prevent the efficient operation of these facilities. In many cases, individual programs and projects cannot succeed without both kinds of supporting activity.

Definitions

The words "program" and "project" are sometimes used interchangeably, and they are also closely related to other concepts, such as "plans" and "activities". In this chapter, the following definitions are associated with each word:

Activity - A specific kind of action which contributes to the attainment of a given objective.

Project - A combination of inter-related activities designed to achieve some quantified goal or goals, with specified inputs and within a specified time period.

Program - An integrated sequence or combination of projects and/or individual activities to be undertaken over time for the purpose of accomplishing a single objective or group of objectives, not necessarily fully scheduled and quantified.

Plan - A quantitative formulation of a given program or project, large or small, providing a general design and detailed specifications for its implementation.

The differences among these four concepts can be

illustrated with examples related to the improvement of livestock marketing in El Salvador. Changes suggested in Chapter V include the construction and equiping of a number of modern sales-yards for live cattle, the sale by weight and later by grade, the modification of restrictions on shipping meat from one city to another, and the development of a packing plant to meet export standards. A Program to improve livestock marketing in El Salvador would be designed to effectuate some such combination of changes, and would indicate an appropriate sequence for the steps to be taken. However, it would not necessarily be fully quantified or scheduled, and it would probably be open-ended, or subject to amplification over time. Periodically, the participating organizations and agencies would probably prepare a program-plan, indicating more specifically the activities, inputs, and expected results for the period to follow.

Within such a program or as a contribution to it, a project might be prepared for constructing and equiping three modern sales-yards at selected assembly points for live cattle. The project would specify the capacity of the yards, their estimated cost, and the expected completion date. One specific activity involved in implementing such a project would be to acquire land for the sales-yards. After completion of the construction project, the program would need to make provision for the continuing activity of operating the yards.

Programs

The programs involved in implementing the proposals of the sector analysis tend to fall into two main classes: (1) those oriented along commodity lines, and (2) those oriented along functional lines. A Livestock Development Program would illustrate the first type, while a Rural Credit Program would illustrate the second type. Broad programs such as these are almost certain to involve a need for cooperation among a number of different organizations and agencies, although each group may have its individual program, tailored to its responsibilities and resources.

The examples mentioned above suggest that some overlap among different programs is perfectly normal--the activities involved in providing credit to livestock producers are just as essential components of a comprehensive Livestock Development Program as of a Rural Credit Program. There need be no duplication of effort or waste of resources if agreement can be reached on the part to be played by each agency in the implementation of several programs of overlapping scope. Coordination of programs overlapping in the manner indicated above will help to assure that the activities to provide credit for cattlemen are integrated with other activities needed for development of the livestock industry, and also that they are integrated with activities for providing other kinds of rural credit. Overlap among various projects is much less normal or desirable.

Projects

The projects that must be implemented to fulfill the goals of the sector analysis also tend to fall into two main classes: (1) those projects involving major investments for developing new facilities and/or services, and (2) those projects involving the performance of certain services during specified time periods, without major new investments. An example of the latter type of project would be the training of 100 individuals for intermediate management positions in various kinds of livestock marketing facilities. Even such a project involves some combination of investment and service, but it can scarcely be placed in the same class with a project to construct one or more slaughter plants or a major wholesale market terminal.

Determining Priorities

Programs tend to be open-ended and implemented through plans developed from year to year. Therefore, they are not generally subject to the same kind of pre-evaluation that is possible for fully developed investment projects. Programs can be evaluated for internal consistency and completeness, and annual program plans can be evaluated in terms of the relationship between inputs and expected results. However, they do not tend themselves to a quantification of the benefits and costs as do most projects. This is especially true when educational activities, including research, represent

major components of a program, as is often the case. Almost by definition, the benefit/cost relationships for research are unpredictable, although historical experience suggests that, broadly-speaking, the pay-off from research has been extremely high.

It follows that the task of setting priorities applies primarily to establishing hierarchies for projects rather than for programs, and especially for projects of the investment type, which involve the commitment of large blocks of resources, frequently obtained at least in part from international lenders. No wholly mechanical procedure seems appropriate in the present context, but the priorities which will be suggested later in this chapter are based primarily upon judgements related to the following kinds of criteria:

1. The total contribution of the project to attainment of suggested goals, without disproportionate drain on scarce resources, including trained technical and administrative personnel.

2. The impacts of the project upon employment, income, income distribution and foreign exchange earnings or savings.

3. The urgency and timeliness of the project as a pre-requisite or complement to other significant projects or activities.

4. The efficiency of the project as measured by more or less conventional procedures for benefit/cost analysis.

The Major Programs and Projects

Any classification of the programs needed to advance the development of El Salvador's agricultural sector must be somewhat arbitrary, inasmuch as many alternative groupings and sub-divisions would be possible. Here, the main needs will be summarized within 10 programs, including five of the functional type (Education, Research, and Extension; Water Resources; Marketing; Rural

Credit; and Improving the Welfare of Rural People) and five of the commodity type (Forestry, Coffee, Fruits and Vegetables, General Crops, and Livestock). Individual projects will be discussed under the corresponding programs, but the assignment of priorities will be reviewed in a final summary section. Emphasis in both programs and projects is on steps that need to be taken in the near future to assure continuing progress toward achievement of goals for the 1970-90 period.

As various agencies are active in each of the 10 program areas, an inter-agency technical committee for each area should be formed and assigned the responsibility for preparing a coordinated annual program plan that includes a progress report covering the preceding year. Each annual program plan should be reviewed by a program advisory council composed of individuals representing a variety of interests in the given program area. A Livestock Council of this general nature has been created by the Minister of Agriculture, and councils providing broad representation in other program areas should be formed to review the proposals of the respective inter-agency technical committees. The approved program plans should be used in preparing program budgets, as part of the national planning process. The program budget becomes the instrument for monitoring progress toward meeting program goals, as discussed in Chapter VI.

Program 1. Education, Research, and Extension

Earlier chapters have emphasized the urgency of accumulating more adequate knowledge about modern techniques and their application in El Salvador's agricultural sector, and of disseminating this knowledge to farm producers, participants in the agricultural marketing process, and leaders of government. This requires vastly increased research and extension efforts, together with the training of technical workers.

At present, El Salvador's annual outlay for agricultural research is only about ¢1.4 million, or about 0.2 percent of the gross income of the agricultural sector, whereas a corresponding figure for some of the more developed countries is about 3 percent. The fact that El Salvador has only 70 field agents for agricultural extension indicates the relatively low level of activity

in disseminating available information.

One need only examine the record of recent crop losses to insects and disease to appreciate the need for the kind of adaptive research which could produce resistant crop varieties and adequate control programs, appropriate to local conditions. Much of the basic work has been and is being done elsewhere, but such work will be useful in El Salvador only after adaptation through local research efforts, and after dissemination to local producers.

A broad program of education, research, and extension has been proposed as a means of overcoming deficiencies in present programs and to provide much of the impetus for attaining the proposed production goals. Execution of this program hinges on a major reorganization and expansion of present activities, through establishing and providing continued support for the development of a National Center for Agricultural Technology (CENTA) The exact content of the research, extension, and teaching phases of the program will naturally be refined from year to year, as the Center takes shape, but the project which has been outlined for development of the Center reveals its overall dimensions.

Project 1.1. Establishing a National Center for Agricultural Technology (CENTA).

The proposed National Center will be organized as an autonomous unit and will absorb the National School of Agriculture. This unit will be equipped and staffed to conduct a broad program of research, to broaden the teaching role of the National School, and to provide support for a greatly expanded and intensified extension effort.

The final design of the CENTA program is now being completed by a committee named for this purpose by the Minister of Agriculture. The main features of the program described below were developed by Dr. George W. Westcott of RRNA.

Agricultural Research Needs in El Salvador.

The research objectives are the following:

1. A broad combination of research on production problems of coffee, cotton, and other crops, with special efforts to achieve a better understanding of means for attacking the insect, disease, and weed complex and to develop crops with promising export potentials.

2. Analysis of the use of irrigation water on specific crops, with respect to timing, amounts, and methods of application.

3. A first class program of livestock research, with special emphasis on cattle and milk goats.

4. Experimentation in the utilization of by-products and the processing of foodstuffs, including coffee, and agricultural raw materials.

5. Research on the processes and facilities of marketing and distributing agricultural products.

6. Research in the field of farm management and price policy.

To fulfill the needs for a broadened national agricultural research program which will have enough impact to sustain a 5 to 6% agricultural growth rate, it is recommended that the present research program be expanded as rapidly as is feasibly possible to include 104 units as a minimum. This would include the present set-up in coffee research plus another four units in finca management and marketing (including utilization) research. The non-coffee research would involve 11 administrative units and 89 research units.

For purposes of this presentation a research unit consists of (1) an experienced top-level foreign research scientist, (2) a Salvadoran research scientist with university level training and the potential for

advanced graduate training, (3) a technical helper, and (4) a bilingual secretary. The annual cost per research unit per year is assumed to be ¢110,000 based on the following: foreign research scientist, ¢75,000 (¢50,000 for salary and ¢25,000 for transportation, equipment and maintenance); the Salvadoran research scientist, ¢18,000; the technical helper, ¢3,600; the bilingual secretary, ¢6,000; and overhead expense, ¢7,400 - total, ¢110,000.

An administrative unit consists of (1) a Sub-director experienced in scientific research and administration, (2) a bilingual secretary, and (3) a technical helper. The annual cost per administrative unit per year is assumed to be ¢40,000 based on the following: the sub-director, ¢24,000; the bilingual secretary, ¢6,000; the technical helper, ¢3,600, and overhead expense, ¢6,400 - total, ¢40,000.

The total annual cost for research would be ¢10,930,000 of which ¢700,000 would be for coffee (the present annual expenditure of ¢500,000 plus ¢200,000 for four new research units) and ¢10,230 000 would be for non-coffee research consisting of 11 administrative units each ¢40,000 and 89 research units each ¢110,000. This assumes a full staff. Usually a 10% vacancy rate prevails. This would in reality, bring the annual research cost down to approximately ¢10,000,000.

The organization needed (as expressed in units) for a unified and integrated National Agricultural Research Program in El Salvador has been tentatively designed as follows:

ADMINISTRATION

Sub-Directors or Section Heads for:

1 Plant Science - Fiber Crops, Sugar Cane, Cereals and Beans, Oil Crops, Vegetables, Fruits, Nuts, and Forages.

1 Animal Science - Ruminants (Goats and Cattle --meat and milk), Pigs and Poultry.

1 Marketing and Farm Management.

1 Plant Pathology.
1 Entomology.
1 Chemistry and Soils.

1 Agricultural Engineering and Irrigation Technology.

1 Rural Community Enterprise.

1 Biometrician - Experimental Design.

1 Regional Collaboration.

1 Librarian. 11 administrative units

Below are the units suggested for a National Agricultural Research Program. These are listed by commodities (except irrigation, engineering and economics). It is assumed that these units will be grouped into departments according to their disciplines as outlined above and then regrouped into teams to work on specific commodities as listed below -- all of this under the administration of the National Center for Agricultural Technology.

NON-FOOD CROPS

COFFEE - Continue present program and add four units in management and utilization 4 research units

TOBACCO

FIBERS

Cotton

2 - Agronomists - Variety Development-Cultural Technology

1 - Soils Fertility and Water Use Specialist

3 - Entomologists (one on mechanics of control)

1 - Plant Pathologist — 7 research units

Kenaf (including henequen)

1 - Agronomist - Variety Development-Cultural Technology

1 - Utilization (Processing and Marketing) Specialist

½ - Entomologist

½ - Plant Disease Specialist — 3 research units

CEREALS

Corn

1 - Agronomist - Variety Development-Cultural Technology

1 - Soils Fertility and Water Use Specialist

½ - Entomologist

½ - Plant Pathologist

½ - Chemist - (to back up agronomist and soil specialist)

1 - Utilization (for food and industrial use) Specialist — 4½ research units

Grain Sorghum

1 - Agronomist - Variety Development-Cultural Technology

½ - Entomologist

½ - Plant Pathologist

½ - Chemist - (to back up agronomist and soils specialist) — 2½ research units

Rice

1 - Agronomist - Variety Development-Cultural Technology

1 - Soils fertility and water use specialist

1 - Entomologist

1 - Plant Pathologist

1 - Utilization Specialist — 5 research units

Yuca

1 - Agronomist - Variety Development-Cultural Technology-Soils Fertility and Water Use

1 - Utilization Specialist — 2 research units

LEGUMES

Beans

1 - Agronomist - Variety Development-Cultural Technology

1 - Soils Fertility and Water Use Specialist

1 - Entomologist — 4 research units

1 - Plant Pathologist

OIL CROPS

Soya (soybeans)

Cacahuate (Peanuts)

Ajonjolí (Sesame)

Girasol (Sunflower)

Higuerilla y otros

2 - Agronomists - Variety Development-Cultural Technologist

1 - Soils Fertility and Water Use Specialist

1 - Entomologist

1 - Plant Pathologist

1 - Chemist and Utilization Specialist — 6 research units

FORAGES AND PASTURES

1 - Agronomist - Variety Development-Cultural Technology

1 - Soil Fertility and Water Use Specialist

½ - Entomologist

½ - Plant Pathologist

1 - Chemist

1 - Utilization (for livestock) — 6 research units

SUGAR CANE

1 - Agronomist — 1 research unit

VEGETABLES

3 - Vegetable Specialists - Variety Development Cultural Technology

1 - Soils Fertility and Water Use Specialist

1 - Entomologist

1 - Plant Pathologist — 6 research units

FRUITS

Citrus

1 - Citrus Horticulturist - Variety Development -

Cultural Technology

1 - Entomologist

½ - Soils Fertility and Water Use Specialist

½ - Pathologist

½ - Utilization Specialist

Non-Citrus

1 - Horticulturist for mangos, avocados and other crops - Variety Development-Cultural Technology

1 - Banana Horticulturist - Variety Development - Cultural Technology

1 - Entomologist

½ - Soils Fertility and Water Use Specialist

½ - Pathologist

½ - Utilization Specialist — 8 research units

NUTS

Macadamas

Cashews

Others

2 - Horticulturists - Variety Development-Cultural Technology-Soils Fertility and Water Use — 2 research units

FORESTRY

1 - Forestry Specialist

1 - Forest Products - Utilization Specialist — 2 research units

LIVESTOCK

Ruminants

Cattle - meat
milk

1 - Dairy Animal Scientist - Breeding

1 - Dairy Nutritionist

1 - Dairy Management - Systems Specialist on Dairy Records

1 - Dairy Management - Systems Specialist on Dairy Farm Management

1 - Beef Animal Scientist - Breeding

1 - Beef Animal Nutritionist

1 - Beef Management Systems Specialist

1 - Reproduction Physiologist

1 - Animal Pathologist

1 - Parasitologist — 10 research units

Pigs

1 - Swine Specialist (Breeding and Management Practices)

1 - Swine Nutritionist

1 - Swine Sanitation and Disease Specialist — 3 research units

Poultry

1 - Poultry Specialist — 1 research unit

Fish

1 - Fish Culturalist (Environment and Management)	1 research unit

Apiculture

1 - Apiculturist	1 research

IRRIGATION

1 - Irrigation - Water Use Specialist	
1 - Anti-Salinity Specialist	2 research units

AGRICULTURAL ENGINEERING

1 - Land Stabilization Specialist (Erosion Control)	
1 - Farm Structure Specialist	
1 - Farm Labor Efficiency Specialist - Labor Simplification with Low Capital Investment	
1 - Farm Water Supply Specialist - Wells, Tanks, Ponds, etc.	
1 - Farm Storage Specialist - Crop Drying Refrigeration	5 research units

ECONOMICS

Marketing*

2 - Marketing Specialists for Domestic Markets	
1 - Marketing Specialist for Regional Markets	

* The work of the marketing and farm management research technicians may in some instances, involve the team approach based on commodities or functions.

1 - Marketing Specialist for World Markets	4 research units
Farm Management*	
2 - Research Specialists	
1 - Irrigation Management Research Specialist	3 research units
TOTAL	104

A staff as outlined above would represent 201 research technicians for the country**. This would give a ratio of one research worker for every 1,200 farmers as compared with one for every 5,000 at present and the standard set by CIDA of one for each 800 farmers.

To make maximum progress, a national coordinated program of production and marketing research should be developed for each important crop or livestock enterprise to be carried on with teams of appropriate scientist and directed to definite national goals.

Agricultural Extension Needs in El Salvador

At present there are approximately 5,000 farmers on the average for each of the 50 Extension field offices. If the number of Extension field offices were increased to 125, then practically every farmer in the country would be within reach of the services of an extension field office and agent. If the number of agricultural extension field agents were increased to four for each office then there would be a ratio of 500 farmers for each agricultural extension field agent as compared to

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* See footnote on page 16.

** This is based on two research workers for each of the 93 units proposed plus the 15 researchers now in the Instituto Salvadoreño de Investigaciones del Café. The 35 present researchers in Investigaciones Agronómicas would be absorbed into the 93 units under the proposed reorganized organization.

one to every 3,600 farmers now and the standard set by CIDA of one for each 400 farmers. With proven modern extension techniques such as the use of meetings, local leaders, and mass media, and with adequate transportation, this would provide effective extension contacts with every farmer every year. It would provide every farmer with continuous contact with extension teaching. This is necessary if transformation to modern technical agriculture is to be accomplished within one or two generations (15 to 30 years).

Table VII-1 outlines the organization (with associated annual budget) based on 125 field offices with four agricultural field agents for each office which would be needed to give sufficient impact to sustain a 5 to 6% agricultural growth rate.

Needs for Educational Facilities for Training Agricultural Technicians in El Salvador

Table VII-2 shows the annual need for graduates to maintain an expanded program of Education, Research and Extension in El Salvador based on an annual turnover of 20% within the research and extension staffs. This does not include maintenance requirements for the faculties of the National School of Agriculture and the Faculty of Agronomic Science at the University or the needs for trained agricultural technicians in other government agencies and private agricultural enterprises.

It is assumed that the 20% turnover will represent the movement of trained personnel into these other institutions and into private enterprises and thus, this will be sufficient to maintain the trained manpower needs in the agricultural sector for sometime to come. If the rate of turnover proves to be higher as the rate of agricultural development increases, the estimated amount of training needs will have to be adjusted upward.

Table VII-1 Organization And Annual Budget For A National Agricultural Extension Program In El Salvador
(in colones)

Administration	Per month	Total per month	Total per year	Total salaries	Total other field expenses
1 Extension Director...	¢2,500	¢ 2,500	¢ 30,000		
1 Ext. Sub-Director....	¢2,000	¢ 2,000	¢ 24,000		
4 Supvrs. Massive Demonstrations.....	¢1,200	¢ 4,800	¢ 57,600		
1 Dir. - 4C.....	¢1,500	¢ 1,500	¢ 18,000		
4 Supvrs. 4C.....	¢1,200	¢ 4,800	¢ 57,600		
1 Dir.-Agriculture.....	¢1,500	¢ 1,500	¢ 18,000		
12 Supervisors Agr.....	¢1,200	¢ 14,400	¢ 172,800		
1 Director - Home.....	¢1,500	¢ 1,500	¢ 18,000		
12 Supervisors Home.....	¢ 800	¢ 9,600	¢ 115,200		
37 Helpers.....	¢ 300	¢ 11,100	¢ 133,200	¢ 644,400	
Information					
25 Specialists.....	¢ 600	¢ 15,000	¢ 180,000	¢ 180,000	
Fish Culture					
1 Head, Section.....	¢1,200	¢ 1,200	¢ 14,400		
2 Pisciculturists.....	¢ 900	¢ 1,800	¢ 21,600		
12 Supervisors.....	¢ 800	¢ 9,600	¢ 115,200	¢ 151,200	
Field					
(125 field offices)					
125 Agronomists.....	¢1,000	¢ 125,000	¢1,500,000	¢1,500,000	
(College Degree)					
375 Agronomists.....	¢ 600	¢ 225,000	¢2,700,000	¢2,700,000	
(Vocational)					
125 Home Agents.....	¢ 500	¢ 62,500	¢ 750,000	¢ 750,000	
Supplies and Equip.....	¢1,000	¢ 125,000	¢1,500,000		¢1,500,000
125 Helpers,					

continued--

Table VII-1 Organization And Annual Budget For A National Agricultural Extension Program In El Salvador
(in colones)
continued--

Field	Per month	Total per month	Total per year	Total salaries	Total other field expenses
Second Class.....	¢ 250	¢ 31,250	¢ 375,000	¢ 375,000	
125 Cars*.....	¢ 80	¢ 10,000	¢ 120,000		¢ 120,000
500 Motor cycles**...	¢ 15	¢ 7,500	¢ 90,000		¢ 90,000
			Sub-total.....	¢6,300,600 (74%)	
			add for non-salary expenses	2,199,400 (26%)***	
			Total.....	¢8,500,000	

* 1,500 Km. per month c/u .60 centavos per Km. (Based on gasoline at .02 per Km. which is 33% of total maintenance cost)

** 1,500 Km. per month c/u .010 centavos per Km

***Includes all other non-salary expenses.

Table VII-2 Annual Needs For Graduates To Maintain An Expanded Program Of Education, Research And Extension In El Salvador*

(Based on 20% Annual Turnover in Personnel)

Necessary staff	High school or vocational level	College level	Graduate school level (Masters) 1 year	Graduate school level (Doctors) 3 years
Extension				
37 Administrators	8	8	8	
25 Information Specialists	5	5		
15 Fish Culture Specialists	3	3	3	
Field; 125 agronomists (college)	25	25		
" 375 agronomists (vocational)	75			
Research				
100 Doctorate level Scientists	20	20		20
100 Bachelor Level Assistants	20	20		
Total Needed Annually to maintain staffs on basis of 20% Annual Turnover	156	81	11	20

* This table does not allow for "dropouts" from one level to another.

Suggested Budget For Training Students In Foreign Countries

	Number Attending each year	Cost per year		Total cost
25 College Degree Graduates per year* 3 years each**	75	$3,000	=	$ 225,000
10 Masters Degree " " " - 2 years each	20	3,500	=	70,000
20 Doctorate Degree " " " - 3 years each	60	5,000	=	300,000
	155			$ 595,000
Total cost for 155 students per year				$1,487,500

* Assuming that approximately 1/3 of the College Degree students receive their training in foreign countries.

**Graduates of the National School of Agriculture will need only two years in the U.S.

This statement does not deal with the needs during the build-up stage of the first 5 to 10 years. Obviously it will require time to tool up and increase the number of graduates to fill the "pipelines" sufficiently to achieve the levels presented in this table. No attempt is made in this brief to prepare a schedule for the build-up period.

Combined Proposed Budget

The total annual budget is presented in table III. As previously stated El Salvador is presently investing ¢3,700,000 in agricultural education, research, and extension. This is approximately one half of one percent (0.55%) of its gross agricultural income. The more developed countries are now investing approximately seven per cent (7.0%) of gross agricultural income in agricultural education, research, and extension. This is about 13 times more per unit of gross agricultural income than is spent by Salvadorans. It is proposed that El Salvador's annual investment in agricultural education, research, and extension be increased slightly more than six times or to 3.7% of its present gross agricultural income. This would still be only about half of that invested per unit of gross agricultural income in most of the more developed countries. However, this program would be ample for El Salvador for some time to come since research methodology and much basic knowledge uncovered by research elsewhere can, with some adaptation, be transferred to El Salvador.

The average benefit-cost ratio could be more than 30 to 1. University of Chicago economist, Dr. Avi Grilliches, estimates that developing hybrid corn cost the United States 36 million dollars between 1910 and 1955 and 3 million dollars annually since then. But every dollar spent returned 700%. Grilliches reports an annual return of some 1,300% for each additional dollar invested in agricultural research and extension education in the United States.

Table III Suggested Total Annual Budget

	Now	Proposed
Agricultural Research	¢1,000,000	¢10,230,000
Coffee Research	500,000	700,000*
Extension	800,000	8,500,000
National Agricultural School ..	700,000	2,000,000**
Faculty of Agronomic Science ..	700,000	2,000,000**
Foreign Training.....		1,500,000**
Interest and Amortization of ¢10,000,000 initial investment in land, buildings & equipment.....		500,000***
	¢3,700,000	¢25,430,000

Annual Investment

Present	
El Salvador invests ¢1,500,000 in research.	0.22% of gross agrl. income (¢675,000,000)
U.S. invests in research.	3.1% of gross agrl. income
El Salvador invests ¢3,700,000 in research, education, extension.	0.55% of gross agrl. income (¢ 675,000,000)
More developed countries invest in research, education, extension.	7.0% of gross agrl. income
Proposed	
El Salvador will invest ¢10,000,000 in research	1.56% of present gross agrl. income (¢675,000,000)
El Salvador will invest ¢25,000,000 in research, education, extension	3.7% of present gross agrl. income (¢675,000,000)

* Including 4 new coffee research units.
** This would include cost of training the faculty to train the professional technicians and scientists.
*** 30 year loan at 3%.

It is believed that these estimates are liberal and will bear up under detailed study. It should be borne in mind that the estimated annual cost of ¢10,000,000 for research is the largest item in the estimate. It is assumed that by the end of 10 years, the foreign scientists can begin to be phased out. This will cut the annual cost per research unit in half or from ¢110,000 to ¢50,000 or the overall annual research budget from ¢10,000,000 to ¢5,000,000 This reduction will amply offset unforeseen research needs that may arise during the next 20 years.

Recommendations

Although there is no question regarding an extremely high pay-off for investment in education and research, the problems of financing this proposal are formidable. The financing should be arranged (1) without detracting from investment needed in other sectors, and (2) without detracting from other investment needs which will arise in the agriculture sector to advance agricultural development as technical knowhow is developed through agricultural research and education.

In other words. El Salvador must have balanced development between the agricultural and non-agricultural sectors, but in order to achieve this balance agricultural education, research, and extension must be given a large push as outlined here if the agricultural sector is to make its necessary contribution to overall development.

The proposal does not preclude the idea of regional cooperation whenever possible and feasible, and in the same manner as regional cooperation is practiced by the Land Grant Universities in the United States.

Individual states in the United States have each supported and benefitted from a Land Grant University-research- extension complex. On the basis of the number of farms and agricultural resources, the need for a Center for Agricultural Technology in each Central American country is even greater than the need for a Land Grant University complex in each of the States in the United States.

Compared with the Land Grant University complexes in the United States the cost of the Program outlined herein would still only be one-half as large per unit of agricultural output as in the United States. This is reasonable. Even though the management of soils, animal productivity, and the control of diseases and insects under sub-tropical conditions requires much more sophistication than in the temperate zones and adaptive research must be done locally, there is much knowhow that can be imported from other parts of the world-for example,basic scientific developments and research techniques and

methodologies.

1. It is recommended that an international agency such as the World Bank, the Interamerican Development Bank or the Agency for International Development sponsor a team or panel to consider the feasibility of the program as outlined in this statement. This team should consist of experienced research scientists and administrators drawn from the Foundations, the United States Department of Agriculture, the Land Grant Universities of the United States and from the International Agencies themselves. This team should include the best expertize in agricultural education, agricultural research and agricultural extension. In carrying out this assignment they should advise the GOES in preparing a comprehensive Plan or a National Program of Education, Research, and Extension for the agricultural sector of El Salvador. Also, this team or panel should be capable of planning the physical equipment (land, buildings and laboratories) necessary to carry on this Program. They should prepare schedules and time tables for the build-up of this program with respect to facilities and personnel.

2. It is recommended that a consortium be created to work with the Government of El Salvador in developing the plans and sources for financing this Program over a period of say, 10 or 20 years. By the end of the 10-year period the increase in agricultural output should adequately and comfortably provide and support the ongoing program as well as repaying the earlier borrowings. This is a phase that must receive the attention of the panel. It is assumed that by the end of 10 years, the foreign scientists can begin to be phased out as rapidly as they can be replaced by highly trained doctoral level Salvadoran scientists. This will reduce the cost of the research program by approximately one- half.

3. In El Salvador there is a tendency to splinter research and extension among many different agencies, --for example among ABC, META, MEGA, and MEPO. This is costly and expensive. With research and extension inadequately supported, other agencies are forced to create their own extension and research technical facilities. There is now a separate Research Institute for Coffee.

Separate research Institutes are being considered for cotton and livestock. There is no end to such proliferation. It is an extravagant dissipation of professional research and administrative talent and physical facilities.

It is recommended therefore that all agricultural research and extension be concentrated under one administration and be associated as a National Center for Agricultural Technology with the National Agricultural school.

4. It is further recommended that the Faculty of Agronomic Science of El Salvador University be broadened in its disciplines and tied into the National Center for Agricultural Technology through a Cooperative Agreement such as is used between the United States Department of Agriculture and the State Land Grant Universities.

5. It is recommended that agricultural economics and sociology research and extension eventually be moved to the National Center for Agricultural Technology and that the Department of Planning and Evaluation be made a staff organization attached to the office of the Minister of Agriculture. The functions of marketing services such as administering grading and inspection and the gathering and dispensing of market and crop production information would be organized into a Dirección of marketing and statistics in the Ministry of Agriculture.

6. It is assumed that the panel will apply some type of systems analysis as a means of scheduling expenditures in the development of the National Center for Agricultural Technology. This analysis will almost surely support the following recommendation: that at the outset in the development of this program the problems of low salaries and transportation for the Extension Service be corrected and that its facilities and personnel be expanded as rapidly as is feasibly possible in order to extend already known technology to the farmers of El Salvador as quickly as possible. Admittedly, there are some known techniques that could have an immediate impact on agricultural output through the continuation

and intensification of the mass demonstration program so effectively used during the past four years.

Present Status. The proposal outlined above has been under intensive review by the CENTA committee appointed by the Minister of Agriculture. It is expected that the final design of the program prepared by this committee will form the basis for a loan application to be presented to an international organization during the first semester of 1970. BID has expressed a strong interest in this project. Results of the planning activities of the CENTA working committee will be appended to this report when completed.

Program 2. Water Resources.

Although irrigation is practiced only to a limited extent at present in El Salvador, it offers significant long-run opportunities for expanding the output of El Salvador's almost fully occupied lands. Before the long-run potential can be realized, however, solutions will have to be found for many technical and organizational problems, and knowledge of how to make wise use of water resources will have to be widely disseminated. Solving these problems should be the primary objective of the water resources program for the next five to ten years, so that unwise procedures will not have adverse effects upon soil productivity or the delicate ecological balance.

As noted in Chapter V, the benefits of irrigation are highly dependent upon the installation of associated hydrologic measures such as drainage, flood control, and stream channel improvement. They also depend upon wise choice of crops and crop varieties, and of cultural practices. An immediate start toward improving existing knowledge about the management of irrigated farming activities needs to be made through establishing research and test-demonstration activities on a series of actual farm operating units.

Steps now being taken to proceed with the installation of irrigation, drainage, flood control, and land reclamation in Zapotitán will provide a relatively small-scale pilot area where much can be learned in the next few years about the general development and management of irrigation projects. Results of this and additional

pilot projects will be urgently needed to guide the rate of progress on future installations. The results of these projects will also be greatly dependent upon the shaping of national water policy, through such measures as the pending bill which would establish broad new policy with respect to irrigation and drainage.

Accordingly it is suggested that the Water Resources Program give emphasis to the following principal elements during the next few years:

1. Activity to sharpen and define national policy with respect to water resources, including efforts to obtain appropriate legislation.

2. Development of nationwide river gauging and ground-water investigation to provide the information needed for optimum use of hydrologic resources.

3. Development of a project for research and test-demonstration activities on approximately 35 private farms with facilities for irrigation.

4. Collaboration in initiating soil conservation projects on the upper basin areas of all streams and rivers proposed for future main irrigation works.

5. Continuing efforts to provide technical assistance and credit to individual farmers who desire to install private irrigation and drainage projects.

6. Installation of the Zapotitán project approximately as scheduled, accompanied by special efforts to glean from it as much information as possible for use in the development of additional projects.

7. Continued planning as a basis for negotiations to finance additional irrigation projects, especially those of a pilot nature, at an early date. The many studies already completed with respect to some 96,000 hectares of potentially irrigable land represent major progress

toward project preparation. The present schedule for implementing the 10 major investment projects listed below (Projects 2.2. through 2.11) appears in table V-9, Chapter V.

Project 2.1 Research and Test-Demonstration Activities on Private Irrigated Farms. (Preliminary description) The objectives of this project are to determine and demonstrate the results of alternative management systems and practices in crop and forage production under the conditions encountered on representative irrigated farms under private management. To a considerable degree, this means that emphasis will be placed on verifying and demonstrating the advantages of systems and practices which have been found to offer promise under more carefully controlled experimental conditions.

The combinations of practices to be tested will include variations in the use of water and also in the choice of varieties, the use of fertilizer, and in other cultural methods followed. Systems of different crop combinations and rotations will also be tested. In some cases, small parcels of land might be leased or borrowed for experimental activity under the direct control and operation of a research center, but the main emphasis will be on simple plot or field demonstrations which can be incorporated by the farm operator in his normal production activities. Hence, the main contribution of the sponsoring agency will be to provide (a) technical assistance for planning, installing, and evaluating the tests; (b) limited quantities of test materials, special equipment and record forms; and (c) procedures for realizing the demonstration potential of the tests through publicity, meetings, and by other means.

Initial plans for this project should extend over three years; during this period, personnel would include two full-time professionals, a secretary, and a driver. Both professionals would need to be well prepared in the fields of agronomy, irrigation, and farm management, but perhaps in somewhat different proportions. One would probably be foreign and the other local, as it would be difficult or impossible to engage two local professionals with the necessary combination of training and experience.

Project resources should include a four-wheel drive vehicle and adequate budget for its operation and maintenance, an allowance for purchase of special test materials and small equipment, and adequate provision for expenditures associated with disseminating information about the results of the tests.

Responsibility for organizing and initiating the project should at present rest with DGORD, working in close collaboration with other agencies conducting research, extension and credit programs, and with the full participation of CENTA when created.

Project 2.2 Development of the Zapotitán Valley

This is a multiple-purpose irrigation, drainage and flood control project designed to promote the cultivation of about 4,230 hectares and to provide a net of access roads to permit movement within the area. The area of the project is some 30 kilometers west of San Salvador.

Lands in the project area are flat and the soil is fertile; however, agricultural production is low compared with its potential, owing partly to floods during the rainy season and partly to lack of water for irrigation during the dry season. It is estimated that the project would increase agricultural production by 2-½ times. Substantial increases in yields are expected by means of the introduction of improved seeds, improved methods of cultivation, better drainage and irrigation.

To control floods and provide drainage, it is expected that some 42 kilometers of natural canals will be improved by means of an excavation of 1.2 million cubic meters. About 56 kilometers of open drainage will be constructed, involving a total excavation of 250,000 cubic meters. In addition, 40 kilometers of roads with adequate drainage will be constructed. The main road of 10-½ kilometers will pass through the whole valley and will be intercepted by secondary roads. There will be three bridges over the principal rivers.

The irrigation plan consists of an integrated

system of surface and subterranean water. It is projected that 2,090 hectares will be irrigated by means of surface water and 2,140 by means of deep wells.

The Dirección de Grandes Obras de Riego y Drenaje estimated the total investment cost of the project at $6.3 million (¢15.9 million) to be expended during the three-year period, 1970-72. Preliminary estimates of benefit cost ratios of the project are 1.9 to 1 for direct benefits and 3.5 to 1 for total benefits.

Project implementation started in February 1969 with ¢1.7 million committed for the first phase--rural roads and drainage. The sume of ¢3.7 million was provided for the continuation of the project in 1970. These amounts were transferred from the General Fund of the Government. By the end of 1970, flood control, drainage and access roads will have been provided for 3,500 ha. The project should be completed in 1972.

The development plan appears sound. It contains a variety of elements which will make this a useful pilot undertaking to provide experience for guiding the development of other projects. Continued implementation of the plans as now scheduled is recommended.

The scheduling of Zapotitán and the other irrigation and drainage projects is shown in table V-9.

Project 2.3. Irrigation and Drainage in the Usulután-Vado Marin Area.

This project area is located in the southeastern part of the country in the lower basin of the Río Grande de San Miguel. It is bounded on the north by the volcano chain of Usulután-San Miguel, on the south by the mountains of Jucuarán, on the east by the lake of Jocotal, and on the west by the city of Usulután. The project would provide drainage and irrigation for 10,000 hectares, together with the improvement of 60 km. of gravel roads.

At present, the area produces mostly cotton, rice, corn and sorghum. The gross value of present production is an estimated at ¢5.5 million. The project is expect-

ed to increase total agricultural production of the area 2-½ times.

Irrigation will be carried out through the use of underground water. Approximately 170 wells will be needed with an average depth of 100 meters and an average pumping height of 35 meters. The yield should provide 145 cubic meters per hour. Unless future studies establish the feasibility of a better solution, each well will have an independent distribution system of canals.

It is estimated that the total cost of the project will be $7.0 million (¢17.5 million), and the direct benefit-cost ratio 2.2 to 1. The foreign exchange costs will constitute approximately 70% of total investment.

Negotiations have been started with BID for a long-term low interest loan (25 to 30 years at 3% with a 4-year grace period) covering approximately 60% of the total cost of the project. Needed supporting measures for the project include passage of the irrigation law establishing irrigation districts, setting rates for water and other services, creation of an administration to operate the project, organization of the farmers and preparation of arrangements to implement the program and maintain the irrigation works.

A feasibility study of this project was started in October 1967, and has been completed. The next step is to identify a pilot area of 3,000 hectares which may be included in a loan application containing a package of pilot studies for the various irrigation areas. It is recommended that irrigation and drainage be initially undertaken for no more than 3,000 hectares as the effect of large-scale irrigation on insect populations and disease must be researched on a pilot basis before such a project can be undertaken on a large-scale. Work on these 3,000 hectares should be completed by 1974.

Drawing of final plans should be ready for presentation to the financial institutions by the early part of 1970 for construction to be started the following year.

Project 2.4. Irrigation and Drainage in the Sonsonate-Banderas Area (Preliminary Description).

The area of this project extends from the city of Sonsonate south to the Pacific Ocean, being bounded on the west by the Río Grande de Sonsonate and on the east by the Río Banderas and its tributaries. The objective is to drain and irrigate a total of 13,000 hectares and to provide for some 40 kilometers of access roads. It has been estimated that the total production of the area will be increased by roughly 2-½ times. The area grows cotton, sugar cane, rice, corn, sorghum, pastures, and has limited areas devoted to fruits and vegetables. The benefit-cost ratio is estimated at 2 to 1.

At the present time, a large proportion of the project area is in pastures irrigated through very rudimentary systems. It is planned to improve the existing systems and to extend the area under irrigation through better use of water. The works to be built consist of dviersionary structures on the main rivers and canals. To the extent that surface water is not sufficient to irrigate the area, underground water will be tapped, providing that the studies now in course demonstrate the economic feasibility of doing so.

Sonsonate-Banderas requires a final feasibility study, hydrologic studies and final plans and designs. These preparatory measures must be completed and presented to financial institutions in 1972 if construction is to start in 1974.

The project should be undertaken in two stages. The first stage should improve approximately 5,000 hectares now under some form of irrigation, and extend irrigation to an additional 2,600 hectares. This should be completed in 1977, when construction could begin on the balance of the 5,400 hectares in the project area, if sufficient water is available. The current investigations of ground water resources for the metropolitan area of San Salvador undertaken under the UNDP should be extended to the Sonsonate area. A much more detailed study must be carried out in this area before unrestricted pumping of groundwater can be recommended.

The total costs of the project are estimated at $10.4 million (or ¢26.0 million). Costs of the feasibility study are estimated at ¢150,000 and of the final design at ¢300,000. The foreign exchange requirement is estimated at 30% of the total cost of the project.

Project 2.5. Development of the Lower Lempa Valley (preliminary description)

The area of the project beings at the height of San Marcos Lempa and continues almost to the mouth of the Río Lempa for a length of 20 km. The area is bounded to the west by the River Amayo and to the east by the River La Poza.

The project is to provide irrigation, drainage and flood control for about 38,000 hectares. Principal crops include corn, cotton, rice, pastures, oleaginous products; small areas are devoted to fruits and vegetables. Preliminary estimates suggest that the production of the area would increase by 2-½ times as a result of the project.

It is planned to construct a diversion dam immediately above San Marcos Lempa which would produce an amount of water sufficient to irrigate 28,000 hectares by gravity. In addition, pumps will bring water to major canals located at a higher altitude in order to irrigate another 10,000 hectares, most of which are located on the eastern side of the river. It is estimated that approximately 60% of the area would require drainage and flood control. Because of its large size, the project will have to be executed in various stages.

The total cost of the project is estimated at $38.4 million (¢96.0 million). Cost of the preliminary appraisal is estimated at ¢250,000, of the feasibility study ¢600,000, and of the final design ¢500,000. It is estimated that 50% of the total cost of the project would involve foreign exchange disbursements.

A preliminary study has been completed, but all other

studies, plans and designs must be completed by the end of 1979 in order for construction to start in 1982. About 2 years will be required for building the diversion dam and canals. The drainage improvements can be started as early as 1973. The irrigation improvements are scheduled to start in 1984. It appears at this time that the irrigation phase of the project will be feasible only if the construction of the hydro-electric project on the upper Lempa at Silencio is completed, so that the storage capacity of both the Silencio and 5 de Noviembre reservoirs can be used for the lower Lempa irrigation system.

Project 2.6. Development of the Olomega Area.

The location of the project is immediately to the north of Lake Olomega. The long-run objective is to increase the cultivated area from 980 hectares to about 9,000 hectares during the rainy season and to 7,000 hectares during the dry season. The project is expected to effect substantial increases in the output of cotton, corn, sorghum, beans, rice, legumes and pastures. Production at present is extremely limited.

The works to be constructed include the daming and filling of Taisihuat Reservoir which will store 40 million cubic meters; a low concrete weir near the city of San Miguel to divert water of the river; a modern system of irrigation canals for the 9,000 hectares to be irrigated; a drainage system in the irrigated area; a dike and a canal between the Río Grande de San Miguel and Lake Olomega to divert flood waters of the river to the lake, which will serve as a storage and flood control reservoir. Other works include a spillway at the western end of Lake Olomega and a discharge structure and waterway for this lake.

It has been suggested that the project be carried out in two stages: (1) Flood control and drainage; and (2) Irrigation. The first phase could be started in 1975, with the 9,000 hectares to be completed in 1979. This would require the dikes, diversion works and a storage tank north of the lake. The irrigation construction could start in 1980 and be completed in 1984. The necessary studies and plans would need to be completed in 1973 in order for construction to start in 1975.

Total investment costs are estimated as follows:

First phase:	$ 3,600,000	or	¢ 9,000,000
Second phase:	5,400,000	or	13,500,000
Total	$ 9,000,000	or	¢ 22,500,000

Preliminary estimates are that the direct benefit cost ratio will be 1.6 to 1 and that the total benefit-cost ratio will be 3.7 to 1.

The foreign exchange cost component of the project is estimated at about 56% of the total. It is hoped that the IBRD will finance 60% of the total cost of the project.

The International Bank for Reconstruction and Development has received the feasibility study. Approval is contingent upon (1) passage of the irrigation law; and (2) the required counterpart funds to be allocated by the GOES.

This project requires heavy investment. However, it is the key to a flood control problem that affects as much as 20,000 hectares. It is recommended that it be carried out in two stages, as outlined above. The completion of the first phase of the Olomega project is a prior condition for the development of the lower area and specifically for the Jocotal-San Dionisio project.

Project 2.7. Drainage and Irrigation in the High Valley Area of Ahuachapán and Santa Ana.

This area is located between the department of Santa Ana and Ahuachapán. It is bounded to the north by the road to Candelaria de la Frontera; to the east by the Santa Ana-Los Naranjos road, and to the south by the villages of San Sebastián, Salitrillo and Chalchuapa.

The long-term objective of the project is to provide drainage and irrigation for the area. It has been estimated that the full completion of the project would raise the value of production from the present ¢2.4 million to ¢11.6 million, or by 4-½ times. The benefit-cost ratio is estimated at about 1.7.

A survey of ground water resources is needed as well as a complete range of feasibility and engineering studies, plans and designs. These must all be completed in 1973 for construction to start in 1975. This area is particularly suitable for beans and vegetable production. Here, again, research is needed to determine the effect of intensive irrigated farming on new vegetable crops and on the traditional crops now being produced in the area. A pilot project is needed to determine a sound program of crop diversification in the area. It is recommended that a first phase of 3,000 hectares be constructed in the years 1975-1977 and that work on the balance of 8,000 hectares be started in 1981, providing results of the first phase are favorable. The total investment is estimated at $11 million (¢27.5 million). It is estimated that 60% of the financing will be provided through external loans.

Preliminary discussions to obtain financing have been held with the Interamerican Development Bank. Information has been collected and it is hoped to complete the study in the early 1970's. No government funds have been allocated to this project to date.

Project 2.8. Irrigation for the San Miguel-San Esteban Area.

The project area is located immediately to the south of San Miguel and includes land on both sides of the Río Grande. A total of 6,500 hectares would be drained and irrigated, resulting in increased output of cereals, vegetable oils, fibers, and pastures. Preliminary studies indicate a benefit-cost ratio of the order to 2.0 to 1.

The project is also expected to reduce losses presently experienced from frequent droughts, and to make an important contribution to soil conservation. That part of the basin of the Río Grande contributes significantly to the large volume of sediment deposited in the river.

Irrigation will be by means of subterranean water, the presence of which has already been ascertained. Studies have not yet progressed sufficiently to permit firm estimates of costs, but preliminary estimates suggest that the total cost of the project would amount to approximately $6.5 million (or ¢16.25 million).

Initial talks have been held with the British Government about financing. Additional studies and plans must be completed before construction can start. It appears advisable that the project be started on 1,500 hectares only. This is an important cotton producing area, and the effect of irrigation should be tested before irrigating a larger area. In particular, the ecological effects of irrigation on insect population and disease complexes need to be studied and solutions found to any problem that might arise. In addition, careful research is needed to determine the best methods of managing water, the optimum combination of inputs, the optimum cycling of production over a twelve-month period and the development of new varieties. Provision must be made for additional marketing facilities and services. If all goes well, the balance of the land can be irrigated in the late 70's or early 80's.

Project 2.9. Development of the Jocotal-San Dionisio Area (preliminary description)

The Jocotal area is located between El Delirio and Vado Marin, with most of the area north of the Río Grande de San Miguel. The San Dionisio area is located near the mouth of the Río Grande de San Miguel to the south of the village of San Dionisio.

This project is a multiple-purpose project involving irrigation, drainage and flood control. The first stage, scheduled for 1980, will be the straightening of the river, followed by drainage and irrigation construction for 5,000 hectares in Jocotal and 2,000 hectares in San Dionisio during the period of 1981-85. The total cost of the project is estimated at $7 million (or ¢17.5 million). It is estimated that approximately half of the total cost of the project would involve foreign exchange resources. The area produces the same type of crops as the Olomega and Usulután regions. A preliminary estimate of the direct benefit-cost ratio is 1.9 to 1.

Only a brief feasibility study has been completed so far. Services of an engineering consulting firm will be required to conduct a feasibility study, supply final designs andprovide supervision. All such studies and designs must be completed before 1978 for construction to start in 1980. The Jocotal-San Dionisio project will contribute to the third stage of the development of the basin of the Río Grande de San Miguel. Completion of water storage installations, and flood control and drainage of the Upper Olomega will be needed before the Jocotal-San Dionisio project can be undertaken.

Project 2.10. Irrigation in the Upper Lempa Valley (preliminary description)

The 23,000 has.project area contains about 16,000 has. of land with reasonable irrigation possibilities. This will be surface irrigation from the Río Lempa which, it is now estimated, will be able to supply sufficient water for only about 16,000 has. in this area. Only the preliminary study has been completed. All other studies, plans and designs must be completed by 1982 for construc-

tion to start in 1984.

Project 2.11. Irrigation in the Jiboa Area (preliminary description)

This project relates to 9,000 hectares along the valley of the Jiboa River between Lake Ilopango and the Pacific Coast. It would depend upon water from the lake, providing studies demonstrate that the known boron content of the water will not be damaging to crop production. If the results are favorable, final plans and designs will be needed by 1982 in order to start final construction by 1984.

Program 3. Facilitating the Marketing of Agricultural Inputs and Products

Attaining the production goals for 1970-90 will imply a more than proportionate growth in the flows of inputs and products through marketing channels. The Ministry of Agriculture is well aware of the corresponding need for expediting these flows through constructing or modifying facilities, encouraging improved procedures, and seeking comprehensive legal and institutional reforms. Many of these changes are long overdue, as is evidenced by the following weaknesses of the present system:

a) The limitations of existing access roads, making it difficult and costly for input materials and information to reach the farm and for farm products to reach market centers;

b) Inefficient and burdensome procedures for negotiating sales and transferring ownership of products, owing in part to traditional or legal norms and in part to the lack of convenient facilities at central markets and at intermediate asembly points;

c) Large physical losses of cereals, horticultural products, and weight of livestock during the marketing process;

d) Inadequacy of established grades and standards, and of a system for applying them in classifying products to meet the needs of domestic and

foreign markets;

e) Inadequate public and private storage facilities;

f) Sharp fluctuations in the prices of a number of basic agricultural products between the harvest season and the time of greatest scarcity.

g) Health hazards arising from unsanitary procedures followed in the slaughter of livestock and the retailing of milk.

An extensive combination of closely integrated steps will be needed to overcome such weaknesses of the present marketing system as those listed above. They may be classified in the following groups:

a) Expanding and increasing the capabilities of the marketing department within the Ministry's Dirección General de Economía Agrícola y Planificación. The Ministry has indicated its intention of supplying this department with the necessary technical personnel and material resources to undertake studies of the marketing system and formulate procedures that would help to rationalize and promote production, provide essential market information to producers, and formulate price policy.

The need for such studies and planning is clearly evident when one considers the remaining steps needed for improvement of marketing processes. Although the marketing of farm products is primarily an activity of the private sector, efficient results are heavily dependent upon publicly established norms, publicly provided services, and publicly constructed facilities. Changes in any of these factors are unlikely to be effective unless preceded by careful analysis and planning. The marketing department will need to expand substantial ly, with guidance from foreign technicians, if it is to perform these functions.

b) Formulating new or revised legislation to modernize the norms for the classification and sale of products, the maintenance of sanitary protection for consumers without undue restriction to the flow of products, and the improvement of marketing procedures in general.

A bill regulating the production, processing, and distribution of milk is being readied for submission early in 1970. Another bill concerning the establishment of sanitary standards and the inspection of meat has also been presented. Revision is underway on a bill which would permit the pledging of livestock (in lieu of real estate) as collateral for loans to livestock producers. Provision is also being made for the sale of livestock by weight in municipal markets.

c) Providing new facilities for storing, selling, and processing farm products. The principal needs, as well as the status of current proposals to meet these needs, will be indicated under the three Sub-Programs discussed below.

Sub-Program 3.1. Meeting Grain Storage Needs, 1970-1990

A combination of several projects and other activities will be needed to meet grain storage needs over the next 20 years. In Chapter V, total investment needs for the entire period were estimated at ¢142 million for commercial storage and ¢50 million for facilities to be constructed by IRA. In addition, it was estimated that nearly ¢6 million would be invested in on-farm storage. The planning and construction of the facilities will of course extend through much of the 20-year period, with adjustments according to the evolution of production and consumption patterns and of technology.

IRA's total storage needs for 1975 were estimated at 1.37 million quintales in the recent McCoy and Niernberger study. This indicates a need for constructing almost 20,000 tons of additional storage capacity

in the next five years. A project of approximately this scale is being developed within the context of the regional program for cereal storage, formulated by the Banco Centroamericano de Integración.

Project 3.1.1. Expansion of IRA storage facilities (project in preparation)

This project provides for new IRA silos in San Miguel and Santa Ana, and for expansion of the present facility at San Martín. It is proposed to provide San Miguel with a storage capacity of 15,000 tons in the first stage, with possibilities for future expansion to 25,000 tons. The facility at Santa Ana will have an initial capacity of 2,500 tons, expandable to 5,000 tons. Expansion at San Martín would add about 3,000 tons of storage capacity, plus a rice mill and a modern bagging plant.

The cost of the project is estimated at ¢5.9 million, including ¢0.5 million already approved for the new facilities at San Martín. It is expected that 40 percent of the cost of silo construction will be financed through external loans. Construction at San Miguel and Santa Ana is not expected to start before 1971, but construction design has been completed.

Project 3.1.2. Community Storage Construction Sponsored by the Federación de Cajas de Crédito. (Project nearing completion).

The Federación de Cajas de Crédito is developing a system of 16 community storage centers, each equipped with grain driers. About 12 have already been completed. The investment is estimated at ¢60,000 per facility, or a total of ¢960,000. These are located near centers of production and represent a contribution to the needs for commercial storage.

Sub-Program 3.2. Improvement of Wholesale Marketing Facilities

In addition to construction of a major wholesale market in El Salvador, many other smaller projects will

be needed to provide satisfactory facilities for effecting the transfer of ownership of farm products at various locations throughout the country. Later in this chapter, for example, a project for constructing simple but improved livestock sales-yards will be introduced as part of the livestock development program. In the present section, only the San Salvador wholesale market proposal will be reviewed, partly because of its urgency and partly because of its size.

Project 3.2.1 Constructing a Wholesale Market in San Salvador.

The kind of a wholesale market facility needed in San Salvador, together with the associated problems of providing a favorable institutional environment for its successful operation, received extensive treatment in Chapter V. Construction costs were estimated at ¢2.2 million, apart from the value of land (estimated at ¢1.8 million in 1965 for a site of 60,800 sq. meters). A proposal announced by the municipal authorities in late 1969 called for a wholesale market of 20,000 sq. meters, but it is believed that the needs of the city and surrounding area are seriously underestimated in this proposal. Therefore it is urged that the 1969 proposal, an outgrowth of one originally submitted in 1965, be further modified along the lines indicated in Chapter V, so as to provide facilities fully adequate for present needs, with a potential for expansion to meet the additional needs of the next two decades.

Sub-Program 3.3. Developing Processing Facilities.

Both the addition to existing processing facilities and the establishment of new types of processing facilities will be needed in the coming years. In the first case, assistance and encouragement for the planning and financing of private facilities is needed (see the earlier comments on the role of an expanded marketing department); in the second case, research and experimentation may be needed before the feasibility of investments can be determined.

The GOES, under the current five-year plan, is engaged in helping to establish various relatively small-scale processing facilities which would enable the country

to preserve, market, and export several products to other Central American countries, as well as to other parts of the world. Responsibility for the formulation and implementation of these activities is vested in the Dirección General de Investigación y Extensión Agrícola and in the Instituto Salvadoreño de Fomento Industrial.

The list of projects under consideration is not exhaustive, but it does represent a substantial effort of a sort which will need to be continued throughout the 20-year period. The list of studies presently in early phases of development or under consideration (see Table VII-4) includes the conduct of feasibility studies on the construction of facilities for a plant to can the "cayena roja" variety of pineapple, for export; the cultivation and processing of barbasco (a poison from Jacquinia armillario, an evergreen plant serving as a source of hormone extract); two castor oil extraction plants, with daily capacities of 10 and 30 tons respectively; a small alfalfa drying plant, based initially on the production from 1,000 manzanas; processing facilities for various fish and shellfish items; and a modern slaughterhouse which could provide meat satisfying export requirements.

Studies will also be undertaken to determine the feasibility of processing the following products: spices, tomatoes, asparagus, vegetables, chili, frog legs, peanuts, milk and its by-products, honey, rabbit meat, garlic, smoked ham, and citrus products. As noted in Chapter V, the possibilities for preparing and marketing a chilled, tropical fruit salad packed in individual containers for use by institutional users might well be added to this list.

Program 4. Rural Credit

In Section V (F) the estimated net additional credit requirements of the private sector were estimated at ¢622 million. Of this total, some ¢548 million would represent transfers from public sources, which would also need to provide a total of ¢1,022 million for net public investments, working capital, and land acquisition. Clearly, a very large rural credit program is an indispensable key to goal attainment.

Table VII-4. Processing Projects Under Study, 1969

	Agricultural Phase		Industrial Phase			Year of operation
	Area (mzs.)	Investment (¢)	Investment (¢)	Production	Prod. value (¢)	
Pineapple.....	211	151,875	1,173,788	3,600 ton	2,971,165	1971
Barbasco.....	-	-	550,000	8.6 "	1,028,125	1969
Castor Oil						
1st plant.....	2,363	-	380,000	10 ton/day	2,600,000	1st year
2nd plant.....	7,086	-	1,776,646	30 ton/day	5,000,000	3rd year
Alfalfa.....	50	-	-	20,000 qq/day	160,000	
Model slaughter						
-house.....	-	-	5,000,000	-	-	-
Fishery and fish						
processing.....	-	-	220,000	320,000	-	-
Canning of squid						
and small shrimps	-	-	125,000	-	-	-
Precooked foods...	-	-	40,000	-	-	-
Salting of fish...	-	-	40,000	-	-	-
Shark fishing.....	-	-	100,000	-	-	-
Fish flour.....	-	-	150,000	-	-	-

Source: Ministry of Agriculture and INSAFI.

Recognition of the strategic role of rural credit in El Salvador's agriculture led to recent completion of two comprehensive studies prepared under the technical direction of Dr. José E. Tobar Acosta. Results of the first study are presented in a three-volume report entitled El Crédito Agrícola en El Salvador, which analyzes the institutional situation and makes a case for the creation of an agricultural development bank, whose proposed organization is presented in the second study, Proyecto de Creación del Banco de Fomento Agropecuario de El Salvador.

In 1967, the total amount of institutional credit for crops and livestock was only ¢137 million, 73 percent of which was in the form of operating credit for the traditional export crops of coffee, cotton, and sugar. This reflects some of the weaknesses of the present system, which are summarized more fully in Chapter V--only a small input of credit for crops other than coffee, sugar, and cotton, and almost no intermediate to long-term credit for development investments. The Asociación de Bienestar Campesino (ABC) has made an important start in helping to meet the needs of small-scale farmers through a program of supervised credit, but much remains to be done along these lines.

The proposal for the formation of the Agricultural Development Bank rests on the expectation that such an entity would be freed of some of the limitations of existing organizations, and that it could be provided with vastly increased resources for extending rural credit. Thus, the formation and capitalization of such a bank would be an initial step which would influence subsequent development of the rural credit program. Presumably, it would be the agency to administer various special lines of credit, such as those which might be made available for livestock development, as will be discussed in the section of this chapter dealing with the Livestock Development Program.

Project 4.1. Formation and Capitalization of an Agricultural Development Bank

This project comprises the planning activities needed to move from the draft legislation now available to the final organization and capitalization of the pro-

posed Agricultural Development Bank. A work group at the Central Bank is presently engaged in analyzing the delicate problems of administrative and policy inter-relationships between the proposed bank, the Ministry of Agriculture, and other institutions, and in introducing such modifications as may be considered advisable before legislative action. It is hoped that the project will be ready in the Spring of 1970.

It is envisaged that the Bank will function as a semi-public autonomous institution, with shares being held by the State, the Central Bank, and associated Credit Cooperatives. The Bank would absorb the functions and a large part of the personnel of ABC, although it will probably need to maintain a series of separate sub-programs and divisions for meeting the differing needs of various groups within its total clientele.

The Bank would provide the following types of credit:

a) Credit for land acquisition and improvement, including the integration of minifundios and the provision of rural housing;

b) Investment and operating credit for various lines of production;

c) Credit for marketing agricultural products;

d) Credit to rural cooperatives;

e) Supervised credit and directed credit.

It is obvious that the policies of the Bank, the Ministry of Agriculture, the ICR, IRA, and the semi-autonomous Centro Nacional de Tecnología Agrícola will require close coordination.

Important as is the matter of organizing the Bank, this work will be of little significance unless parallel measures are taken to provide adequate initial funding. Pooling the existing resources and reinvesting dividends will not be enough. Principal reliance will have to be placed on the following sources of additional funds:

a) The Central Government, through transfers from the General Fund;

b) The Central Bank, through its Economic Development Funds and special lines of credit;

c) Foreign lending institutions, including AID, the World Bank, IDB, and CABEI;

d) To a lesser degree, through the sale of bonds (guaranteed by the Central Bank) in the international market, and through deposits by the general public.

Among ancillary functions suggested for the Bank would be to foster the cooperative movement in agriculture and to develop some sort of system of crop and livestock insurance.

Program 5. Improving the Welfare of Rural People

Vigorous efforts to implement agricultural programs, execute projects, and realize increased production must serve to improve levels of welfare for rural people associated with the agricultural sector, as well as for other families living in rural and urban areas.

The interdependence of growth in the agricultural sector and in the total economy has been emphasized in this report. Ambitious growth targets for the economy as a whole are unlikely to be realized unless both the agricultural and non-agricultural sectors participate. Production and welfare objectives are also complementary, inasmuch as broadly distributed income gains provide the necessary increases in effective demand for products of both agriculture and industry, while improved health and living conditions contribute to a more productive labor force.

In short, any combination of programs which fails to assure that agricultural producers and workers will share appropriately in the economy's increasing productivity, both in terms of money incomes and in terms of public services for health, education, and general

welfare, will be unlikely to produce the desired results with respect to growth in the total economy. Policies, institutions, and some inter-sectoral programs important for achieving the desired results have been discussed in Chapter VI and will not be repeated here.

Measures which should be initiated within the agricultural sector to improve the welfare of rural people can be grouped under four sub-programs, relating to (a) Economic Information and Analyses, (b) Problems of Land Tenure, (c) Rural Institutions, and (d) Direct Measures for Augmenting Family Incomes. Each of these sub-programs will be discussed briefly below.

Sub-Program 5.1 Economic Information and Analyses

Very little quantitative information is available about the total income position of families related to agriculture by virtue of land ownership, farm operation, or employment for salary or wages. Erroneous conclusions can be reached by mistakenly assuming that levels of total family income can be inferred from the size of parcels of owned or rented land, from the scale of crop and livestock production activities on individual farm units, or from the salary or wage earnings of individual employees. (See section A-5 of Chapter V and Appendix). In fact, it may be assumed that most families associated with agriculture receive income from some combination of these and other sources, and include more than one person with some source of income. The problem of analyzing the actual income situation is therefore extremely complex, and new techniques for obtaining the relevant data must be developed and applied before the problem can be fully analyzed.

The problem of developing improved information about incomes and income distribution in agriculture is obviously closely related to other data needs, and integrated procedures are needed for improving the total availability of information and analyses on the resources, activities, and performance of the agricultural sector. Data on crop and livestock production, and on the use of purchased inputs, are useful for estimating the gross and net incomes of the sector, but special studies on

the distribution of incomes need to be initiated, perhaps in a new section of the Dirección General de Economía Agrícola y Planificación. Initial work should be closely coordinated with the development of plans for the next Agricultural Census, where an effort should be made to provide at least a minimum of cross-reference between the land ownership, production, and employment activities of individuals and families.

As information is developed with respect to income distribution in agriculture, it will become increasingly possible to make meaningful analyses of the impacts of alternative program proposals. As rapidly as possible such analyses should be developed with respect to many of the programs and projects discussed in this chapter, with a view to assuring that the income benefits of the measures undertaken will be favorably distributed.

Project 5.1.1. The Third Census of Agriculture (project in development).

Direct responsibility for conducting the next Census of Agriculture rests with the Dirección General de Estadística y Censos of the Ministry of Economy, but the Ministry of Agriculture has a major interest in assuring the results are as useful as possible for the development of programs relating to the agricultural sector. The Census originally scheduled for 1970 has now been postponed, and it is doubtful that adequate plans and preliminary pilot activities can be completed in time to permit a full census before 1972 at the earliest. Given the large outlays needed for a Census, adequate preparation is more urgent than early completion, but such preparatory work needs to go forward as rapidly as possible. During the preparatory stage, means should be developed and tested for providing a minimum of cross reference information to establish relations between the land ownership, production, and employment activities of individuals and families, for the reasons explained above.

Sub-Program 5.2 Resolving Land-Tenure Problems

The government has recently proclaimed its policy of improving the lives of agricultural families through

a democratic "agrarian reform". The term "agrarian reform" is broad enough to include practically all programs for agricultural development, but much attention is being given to comprehensive measures to improve land tenure relationships. Problems and possible measures have been examined at length in other sections of this report. While the government conducts its examination of various new reform proposals gradual action continues on projects already underway, such as the one presented below.

Project 5.2.1. Agrarian Reform in the Coastal Zone

This project under the jurisdiction of the Instituto de Colonización Rural (ICR) involves the purchase of properties in the coastal zone for assignment to new owners. It seeks to improve land tenure conditions, promote the integration of minifundios, improve the living conditions of farm families, distribute land in economic size units, and promote a more intensive use of land. An immediate objective is to settle about 4,000 refugee families from Honduras.

It is planned to purchase lands with a total area of 19,570 hectares and to develop an area of 8,387 hectares, using funds obtained through the issue of bonds, with the approval of the Ministry of Finance. So far, implementation is behind schedule because of shortages of funds, and such land as has been acquired is said to be of low potential productivity. The preliminary scheduling of investments is as follows:

	1968	1969	1970	1971	1972	Total
	(thousands of colones)					
GOES resources.....	3,000	3,000	1,000	1,000	5,000	13,000
External resources..	-	-	2,000	2,000	4,000	8,000
Totals.....	3,000	3,000	3,000	3,000	9,000	21,000

Sub-Program 5.3. Strengthening Rural Institutions

Rural people can do much to improve their own

situation if they have opportunity and assistance for developing and working through their own institutions. Examples of such institutions would include local committees to sponsor such activities as collective work on road improvement, commodity oriented farmer associations, rural cooperatives, irrigation districts, and credit unions for farmers and rural workers. The Departamento de Fomento Agrícola y Sociología Rural of the Ministry of Agriculture is presently responsible for giving assistance to farmer cooperatives, and other efforts for strengthening rural institutions are obviously closely related.

The Federación de Cooperativas de Ahorros y Crédito de El Salvador (FEDECACES) provides organizational support and guidance to the credit union movement which has begin to show significant progress in El Salvador. The credit cooperatives which have been developed will receive further support with formation of the Instituto Salvadoreño de Fomento Cooperativo, described below in Project 5.3.1.

Project 5.3.1. Developing Cooperative Organization (project in development)

The organization of small farmers into cooperatives would serve the purposes of promoting agricultural production by enabling farmers to pool their resources and borrow on a larger scale and on more favorable terms (in credit cooperatives), by reducing their cost through cooperative purchases (supply cooperatives), and by obtaining better prices for their products (through cooperative marketing). The formation of producer cooperatives would enable farmers to purchase and use equipment that they could not afford to buy on an individual basis.

This project is presently under the jurisdiction of the Dirección General de Economía Agrícola y Planificación and its Departamento de Fomento Agrícola y Sociología Rural. It involves the establishment of cooperatives of small and medium farmers covering all stages from production to marketing. It is expected that the project will deal with all urgent problems relating to the development of the agricultural community such as the cooperative working of the land, the use of improved seed, construction of silos, improvement of livestock and es-

tablishment of schools and centers of health and welfare.

Supporting measures required to ensure the success of the program include passage of the Law on Cooperatives and establishment of a center for cooperative training and community development ("Centro de Capacitación Cooperativa y Desarrollo Comunal") as the organism designed to promote the education and training of farmers in all problems relating to land use, rural administration and community development. This center of cooperative training and community development will have the following sections: (a) agricultural production (by means of demonstration); (b) industrial processing of agricultural products; (c) marketing (cooperative sales of agricultural products under the Departamento de Abastecimiento Cooperativo); (d) social welfare (in combination with public health and home improvement services); (e) credit coops for savings and loans; (f) organization of self-help (community development) services.

The development of cooperatives was started in 1967 with small and medium-size farmers. The first attempt was to organize some 60 to 80 groups of farmers, but only 12 groups succeeded in establishing cooperatives. The membership of these 12 groups varies between 13 and 40, with a total of some 250 members presently enrolled in producer and marketing cooperatives. While these are currently functioning, they are still awaiting legalization.

The law on cooperatives was approved on November 25, 1969. At the same time, the Assembly passed the Ley de Creación del Instituto Salvadoreño de Fomento Cooperativo. This Institute has a broader scope than the Centro de Capacitación Cooperativo y Desarrollo Comunal referred to in the above description, as the Instituto will perform the functions of supervising, auditing, advising, registering, counseling, organizing, legalizing and channelling credits to <u>all</u> cooperatives, and not just to cooperatives in the rural areas. It is expected that the Institute will have an agrarian section to handle rural cooperatives.

Technical personnel responsible for cooperative development and organization are presently spread out among various organizations such as the ABC, the Ministry of Agriculture, INSAFI and the Ministry of Labor. All of these personnel will be transferred to the Institute which will have exclusive responsibility over this area. The Institute is expected to start operations in early 1970.

Sub-Program 5.4. Direct Measures for Augmenting Incomes of Disadvantaged Families

Although the general level of productivity in the agricultural and non-agricultural sectors of the economy will be the primary factor in determining incomes within various strata of families connected with agriculture, there may be need for special programs to augment incomes of certain disadvantaged groups from time to time.

History is replete with examples of over-ambitious efforts in this direction in many different countries, but this does not deny the possibility that realistic programs with limited objectives can be of significant value.

One approach to affecting the levels and distribution of incomes in agriculture is through price support operations. In El Salvador, IRA has had responsibility for regulating the supply of the basic foods on the basis of stable prices, remunerative for the producer and just for the consumer. In practice, IRA's activities have sought to contribute at least modestly to seasonal stability of prices, rather than to effect large income transfers from consumers to producers. The wisdom of this course should be clear from experience in other countries. It should also be clear that price support operations have little to offer to farm laborers, subsistence producers, and the small commercial producers who have little to sell. For these disadvantaged classes of farm families, any direct assistance must be provided through other measures.

The minimum wage law which has been in effect in

El Salvador since 1965 illustrates one such measure, presumably intended to improve the lot of laborers, including those on farms. The exact degree of compliance with this law is unknown, but it is clear that minimum wages are difficult to enforce under conditions of an excessive labor supply and considerable unemployment. Even if rigid enforcement of the law were possible, it would not solve the problem of the laborer left without employment. Only in company with a substantial program of unemployment benefits, either privately or publicly supplied, can a minimum wage law be expected to offer significant benefits to farm laborers as a class.

El Salvador is limited in its capability to implement ambitious measures involving public welfare payments to disadvantaged rural families which would materially improve their levels of living. However, certain kinds of activities can be considered which would tend to be self-liquidating in terms of increasing productivity as well as raising living levels for such families. The Food Stamp Program in the USA for example permits low income families to use the money they would normally spend for food to purchase special stamps which can be redeemed in foods having a greater market value than the price paid for the stamps. Such a program is of very substantial assistance to families involved, does not produce major distortions in market prices, and helps materially to broaden the demand for food products, thus helping to foster growth of output across the board. Like measures to improve water supplies and rural health, such a program also tends to improve the productive capability and performance of a major fraction in the labor force. Possibilities for limited application in El Salvador of some such program on a trial basis deserve early study.

Program 6. A National Forestry Program

About one third of El Salvador's land surface appears best suited for forestry and closely related uses. A comprehensive program for achieving effective use of these lands has been presented as a unit in section V-A4. The main elements in this program include greatly accelerated reforestation, both on public and private lands; the acquisition and development of land for National Forests and Parks; the establishment of an organization and campaign for forest fire prevention and control; the develop-

ment of institutions and educational efforts; and the provision of financial support. These inter-relate with elements of the Research and Education Program, and the Diversification aspects of the Coffee Program.

Total outlays for the 1970-90 period include ¢116 million for acquiring land to be included in National Forests and Parks, plus ¢130 million for development and reforestation activities on both public and private lands. Of the combined total, ¢13 million would be expended during the first five years.

Project 6.1. Reforestation of the Northern Zone, Metapán-Chalatenango

This project involves a combination of reforestation and flood control objectives, and hence has been mentioned in the analysis of water resources problems. However, it is under the jurisdiction of the Dirección General de Recursos Renovables.

The location of this project is along the watersheds of the San José, Chimalpa, and Pacheco rivers in the region of Metapán, department of Santa Ana. In this area, unrestricted cutting of trees has produced erosion in alarming proportions, leading to the silting of the Chimalpa and San José rivers and, in turn,to flooding problems for the City of Metapán.

A closely related problem is that silting of rivers and reservoirs farther downstream has affected the power producing capacity of the Comisión Ejecutiva Hidroeléctrica del Río Lempa (CEL), which therefore has a direct interest in this project. The proposed reforestation is expected to help in preventing continued silting at the Cinco de Noviembre reservoir, a source of power for CEL.

The proposed reforestation will involve the planting of rapidly growing tree species, thus providing an early contribution to reducing El Salvador's imports of commercial woods.

The project is divided into two phases. The first phase involves the planting of 2,000 hectares and the installation of associated soil conservation works, accompanied by efforts to collect necessary information for detailed feasibility analysis and planning with respect to the second phase. The cost of the first phase, or pilot project, is estimated at ¢1.8 million, of which 44 percent is to be contributed by the United Nations Special Fund.

The second phase of the project will be undertaken only if the first phase yields satisfactory result. It involves reforestation of 6,250 hectares, at an estimated cost of ¢1.06 million. Approximately 58 percent of this cost would be contributed by the U.N. Special Fund, with the remainder expected to come from CEL.

The pilot project was recommended by a visiting FAO team. The Government of El Salvador accepted the proposal and submitted an application for partial financing, in the amount of $246,000, to the U.N. Special Fund, to cover technical assistance, equipment, and the training of personnel. A favorable reaction from the U.N. is being awaited.

Project 6.2 Reforestation in the Area of the Reservoir 5 de Noviembre (preliminary description)

Some of the most acute erosion in the country is to the east of the Metapán-Chalatenango area affected under Project 6.1 and constitutes a serious menace to the Reservoir 5 de Noviembre, used by CEL for generation of electricity. An estimated total of 10 million cubic meters of silt are carried downstream annually, of which a third is deposited in the reservoir, threatening to reduce its useful life by half.

Reforestation and other conservation measures are needed on some 20,000 hectares. It is proposed to schedule this work at the rate of 2,000 hectares per year, starting in 1971, with most of the financing to be provided by CEL. The first step will be to undertake the needed feasibility studies and other planning activities.

Project 6.3. Conserving Human and Natural Resources Through Forest Development (preliminary description)

The recent inflow of refugees from Honduras has accentuated El Salvador's chronic problem of providing productive employment for large numbers of persons with limited skills. The tasks of increasing the productivity of forest lands, primarily through reforestation, protection, and rational harvesting, are labor intensive. Thus, they offer a promising opportunity for providing displaced citizens with productive jobs of great national benefit. Such inputs of labor are needed in connection with Projects 6.1 and 6.2 as well as in other areas of the country.

It is suggested that three or more work camps for 200 workers each could be established in areas such as the Metapán high watershed lands, the site of the Reservoir 5 de Noviembre, and the Pinares of the northern Frontier. Feeding, housing, clothing, and discipline could be under the direction of the Armed Forces, while workers would be directed and supervised during the work day by the technical agencies. The pattern would be similar to that of the Civilian Conservation Corps activities in the USA between 1935 and the present. If preliminary project activities proved successful, the scale could later be extended to include from 1,000 to 2,000 or more workers. Sources of international financial assistance for such a project should be explored.

Project 6.4 On-the-Job Training for Technical Personnel and Skilled Workers in Forest Conservation, Through Support from the U.S. Peace Corps (preliminary description)

As El Salvador has very few technical workers trained in forestry, early initiation of an expanded program will require substantial technical assistance. The U.S. Peace Corps program is directed toward supplying individuals with specific skills, such as those which will be needed for in-service training of a corps of Salvadorean forestry technicians. Thus, as soon as conservation activities under the forestry program gain substantial momentum a group of about 20 Peace Corps volunteers could make a significant contribution in providing training and support to a technical staff of the forestry department, which should be expanding in size from about 20 in 1970 to 50

by 1975 and 100 by 1980. Additional training will need to be provided for a growing number of skilled workers and forestry foremen who would work under guidance from the local technicians and the Peace Corps Volunteers.

Project activities would rely upon cooperation with extension workers, representatives of credit agencies, and with groups and organizations which can help to influence opinion, such as schools, churches, and the Amigos de la Tierra.

Further development and scheduling of this project will depend upon progress in the rate of implementing other elements of the forestry program.

Program 7 Coffee Development and Agricultural Diversification

El Salvador depends upon coffee for around half of her total exports, two-thirds of her agricultural exports, and a third of her total agricultural output, all in value terms. Under these circumstances, it is not surprising that special entities have been organized to serve the industry with respect to marketing and research, nor is it surprising that considerable interest has centered in recent years on the possibilities for diversification.

Research results suggest that much can be done to raise the level of production practices followed by coffee producers, thus contributing to increased yields. El Salvador could intensify production on the lands best suited for coffee, divert other lands to alternative uses, reduce costs and increase returns to growers, while continuing to expand total coffee production at a rate commensurate with the growth of domestic and foreign markets, as anticipated in the production goals of this sector analysis.

To achieve these results, it has been proposed in Project 1.1 that the kind of research conducted by the Instituto Salvadoreño del Café be continued and expanded, as part of the overall research and educational program of the Centro Nacional de Tecnología Agrícola.

In addition, the results of studies in progress by the Instituto, with the collaboration of FAO personnel, are beginning to provide guidelines for the development of project activities which would assist in the diversification program. The conclusions to date emphasize the need for the kinds of activities included here under projects of research and education, forestry, fruit production, and livestock development. Special emphasis is placed on local extension efforts for community development, on the use of fast growing tree species for reforestation of lands diverted from coffee, on the need for immediate efforts to provide planting stock of improved quality to growers who would like to expand their fruit enterprise, and on measures for livestock improvement which will be discussed under the livestock development program.

The matter of agricultural diversification, conceived in broad terms, becomes a matter of overall agricultural development. Hence, as the development of projects oriented toward diversification proceeds, it will be important to assure that they are integrated in the total agricultural development effort, for which El Salvador needs to use her limited resources with maximum impact. Present activities for project formulation are identified as the "Proyecto de Diversificación Agrícola" which is outlined below.

Project 7.1. Agricultural Diversification

This project vests in the Instituto Salvadoreño de Investigaciones del Café the responsibility for undertaking feasibility studies and conducting the necessary research to formulate projects that will promote the production of fruits (citrus, lemons, cashew nuts, avocados, mangos, pineapples, bananas and cantaloupes); vegetables (tomatoes, cucumbers, garlic, chili peppers, and asparagus); timber; livestock (for milk and meat); and spices, including cardamon (the fruit of Elettaria cardamomum, an East Indian herb of the ginger family, whose seeds are used in medicine and as a condiment).

The project, instituted in October 1967, is under the technical direction of the FAO. The total cost is estimated at ¢3.1 million, of which 60 percent would be contributed by the United Nations Special Fund. Budgets

for the remainder of the project are as follows:

	1970	1971
	(¢000)	
U.N. Special Fund	396	132
GOES Fund.....	293	160
Totals.....	689	292

Program 8. Fruits, Vegetables, and Horticultural Specialties

In sharp contrast to the situation with respect to coffee, the production of all horticultural products, including fruits, nuts, herbs, as well as vegetables, has made only a relatively minor contribution to El Salvador's total agricultural output, and there have been net imports of many of the kinds of fruits and vegetables produced on a limited scale within the country. Seasonality of production accounts for a considerable share of the periodic imports of such items as avocados, citrus, pineapples, and tomatoes, all of which are exported during the main harvest period. However, there appears to be considerable opportunity for expanding local production to replace imports, increase exports of fresh or processed items, and keep pace with the growth of local consumption needs.

The logic of focussing special attention on opportunities for expanding fruit and vegetable production rests on the following factors:

(1) Generally speaking, El Salvador enjoys a favorable situation, from the point of view of climate, soils, and labor supply for this type of production, as well as a strategic location with respect to Central and North American markets.

(2) Tree fruits represent a high value crop which can be planted on some of the hilly lands to

be diverted from coffee, under conditions where annual crops would be likely to create serious erosion problems.

(3) Cantaloupe, watermelon, and a variety of vegetables are also high value crops which can help to carry the overhead costs of irrigated agriculture.

(4) Almost all fruits, vegetable crops, and horticultural specialties provide opportunity for productive employment of large quantities of labor--first in the production process, and second in processing operations where feasible.

Unless vigorous steps are taken to foster expanded production and processing of such items, it appears extremely doubtful that El Salvador will be able to maintain the proposed growth rates for the agricultural sector as a whole, and especially for agricultural product which could contribute to increased earnings and reduced expenditures of foreign exchange. Rural employment opportunities would also suffer.

At present, the volume, regularity, and quality of El Salvador's fruit and vegetables do not provide a satisfactory basis for effective competition in exporting fresh produce or in large-scale canning operations. Joint ventures and contract production may help to solve some of the problems with respect to the seasonal production of such crops as melons, for marketing at strategic periods in the United States. More important, however, are the numerous opportunities for developing small-scale processing of specialty items, such as frozen mangoes, ready-to-serve tropical fruit salads, icecream toppings, conserves, spices, and medicinals. The country has the physical resources, the labor, and the entrepreneurship for ventures along these lines, although past efforts have often lacked one or more of the necessary ingredients for success.

Some of the needed feasibility analyses are already underway, including projects mentioned under the Marketing Program and the Program for Agricultural Diversification. A preliminary description of a project being outlined un-

der the latter program will be presented below. In addition, vegetables and melons will represent an important potential use for land to be developed under the irrigation projects, and priority attention needs to be given to the general class of horticultural products in the Research and Education Program.

Project 8.1. Production and Distribution of Improved Planting Stock for Selected Fruits (preliminary description based on a proposal by the FAO Diversification Team).

Although there appear to be promising opportunities for some sort of expansion of fruit production and processing, existing sources of planting stock are so unsatisfactory that the necessary appraisal of production possibilities under actual farm conditions is greatly handicapped. Hence, it is proposed to establish sources of improved planting stock on a scale which would permit, first, an ample test of what can be done with such stock under actual farm conditions, and second, the subsequent expansion of plantings if warranted by the results of production experience and marketing prospects.

Since the vegetative cycle for producing planting stock is of 12 to 18 months, implementation of this project in 1970 and 1971 would permit coordinated progress toward expanded fruit production at a time when the results of other studies will be known. During these two years, targets for production of planting stock have been suggested as follows:

	1970	1971
	(000 units)	
Orange	47	119
Lemon	12	23
Tangerine	7	12
Grapefruit	5	9
Cashew	62	94
Avocado	10	20
Mango	10	20
Pineapple	500	1,000

A partial proposed budget, in dollars, is as follows:

Personnel (2 agrónomos and 2 grafters).....	$ 18,000
Equipment (sprayers and dusters, etc.).....	30,000
Vehicle.....	2,000
Plant material.....	20,000
Other production materials.....	20,000
Total.....	$ 90,000

Alternative means of achieving the project objectives need further consideration, and the scale of the project also may need to be reconsidered before final decisions with respect to its implementation are taken. If feasibility studies based on the results from use of this planting stock are favorable, the project outline suggests that total investments in expanding fruit production during 1970 through 1979 may be equivalent to a total of nearly 10 million dollars.

Program 9. A Development Program for General Crops

The crops included under this extremely broad category include corn, grain sorghum, beans, rice, cotton, the oilseeds, sugar cane, and a variety of other plant species grown on a lesser scale. Most farm units in the country produce corn, which is usually planted in association with grain sorghum or beans, whereas the number of producers of any one of the other crops is relatively small and the production areas tend to be somewhat localized.

The general objectives of this program will be to maintain a rate of growth in output commensurate with the growth of local and export demands, to reduce production and marketing costs where possible, and to achieve these results in a manner that will foster an improved level of living for large numbers of farm operators, farm laborers, and their families.

Achieving these objectives will depend on substantial progress in the research and education activities comprising Program 1, on the improvements in marketing techniques and facilities contemplated under Program 3, and on the availability of rural credit at the levels suggested in connection with Program 4. Large inputs of foreign technical assistance and credit will surely be needed to achieve the desired results.

In more specific terms, the program will require:

a) Development, multiplication, and dissemination of improved varieties;

b) experimentation and test-demonstration activities to determine effective levels and methods for application of fertilizers, lime, and plant protection materials;

c) an extremely broad program of extension education on crop production practices and on general farm management, often associated intimately with the development of related plans for use of credit;

d) evolutionary development of the farm supply industry and its local outlets, which preferably should be integrated with facilities for the assembly and storage of grains and other farm products;

e) improvement of rural roads to permit freer flows of input materials, information, and farm products;

f) a general expansion of facilities for marketing crops under improved techniques;

g) a general strenthening of the institutional structure for agriculture.

Several major investment projects related to production of general crops have been covered under other programs. Large numbers of service-type projects will be involved in sub-programs for research, extension,

marketing, and credit. Here we will mention three projects specifically included in the current five-year plan of the Ministry of Agriculture, and the Massive Demonstrations which produced significant results between 1965 and 1967.

Project 9.1 Rice Production (project in development).

The importance of rice has been increasing among the domestic foodstuffs which contribute to the Salvadoran diet. At present, it is an expensive substitute for wheat and corn, but there is hope that El Salvador can reduce the level of production costs to make its rice more competitive on world market as well as at home.

A preliminary list of the major objectives and the proposed means of implementing them is as follows:

a) Increase the area cultivated, especially where irrigation can be practiced;

b) increase the use of improved seeds, fertilizer, and other inputs;

c) provide adequate credit of the following classes:

1) Short-term operating capital for growers;

2) medium term credit (6 to 8 years) for the purchase of machinery and agricultural equipment;

3) long-term credit (12 years) for land leveling, irrigation, and drainage, and for marketirg facilities such as warehouses, silos, dryers, and cleaning equipment;

4) other special lines of credit for debt refinancing, milling and polishing, and export financing;

d) achieve uniformity in the quality of rice for export;

e) provide greater price stability and more incentive to producers, through increasing the proportion of the crop purchased or given a purchase guarantee by IRA, and by establishing a system of price differentials according to quality;

f) provide a system to supply better information with respect to both internal and external markets;

g) establish a policy of freely exporting rice, while stimulating local demand through informational campaigns;

h) expand rice storage capacity, both at regional points and at the IRA installation in San Martín.

Further study of these objectives and procedures is clearly needed before they are incorporated in a more detailed loan proposal to be submitted in early 1970, possibly to BID.

Project 9.2. Protecting Cotton from Insects and Diseases (project in execution).

Experience in El Salvador, as in many other countries, has shown that continued cotton production leads to an intensification of insect and disease problems. As a result, increasingly costly spray programs have been adopted in recent years, raising production costs to levels that have been uneconomic in many instances. Possible solutions for this problem are foreseen in the development and distribution of more resistant varieties, and in more selective timing and application of control materials, according to the emergence of insect populations and of disease problems, as determined by continuous professional surveillance.

The Ministry of Agriculture has already made considerable progress in such insect control efforts, utilizing foreign technical assistance personnel. Further efforts in this direction and also in developing more resistant strains of cotton will represent an important

project for early attention, upon formation of the Centro Nacional de Tecnología Agrícola.

Project 9.3 Massive Demonstrations (project suggested for re-activation).

In Chapter V, reference was made to the massive demonstration effort conducted between 1965 and 1967 to convince farmers of the importance of adopting improved practices in the production of corn and several other crops. During that period, about 3,000 corn producers per year were provided seed, fertilizers, and insecticides sufficient for demonstration plots of 400 sq. meters each. Although the immediate effectiveness of the project may have been overestimated at the time, evidence shows that it did produce important impacts, and that continuation of the same kind of activity, not only for corn but also for such crops as rice, beans, grain sorghum, and sesame, would be desirable.

This kind of project also represents an ideal procedure for introducing new and inexperienced extension workers to extension work in general and to their assigned area. Hence, with the proposed expansion of extension activities foreseen in connection with the development of the National Center for Agricultural Technology, such a project as this would have dual advantages.

The applicability of such a program with respect to corn and the associated crops of beans and grain sorghum is set forth in the discussion of adjustment I and the accompanying Table V-18 of Section V-B. Table V-18 suggests that 31,500 commercial farms, 24,000 subsistence units of a hectare or more, and 90,000 subsistence units of less than a hectare could benefit from the adoption of improved practices in corn production alone. The annual value of the additional output to be generated is estimated at 2.1 times the annual cost of public and private inputs combined, and this ratio would be 2.5 to 1 for the large group of small and medium commercial farms. Results from the adoption of improved practices on other crops have not been estimated in corresponding detail, but there is strong reason to expect roughly similar benefits.

Accordingly, it is recommended that the massive demonstration effort be re-activated immediately, and expanded as rapidly as the addition of new extension personnel will permit, with special emphasis on using this as a means of training extension workers and volunteer associates as well as farmers.

The proposed goals would be to realize 30,000 demonstrations on corn in the next five years, mostly on commercial farms and on subsistence units of one hectare or more, plus an equal number of demonstrations for all other crops combined. Each demonstration should be conducted in two consecutive years on a given farm or on two neighboring farms, to gain the educational advantages inherent in repetition and the testing experience represented by two different crop years.

Detailed procedures and guidelines for conducting such demonstrations are available in mimeographed report prepared by Dr. Benjamín J. Birdsall and Agrónomo Carlos Quiteño, available in USAID files.

Project 9.4. Soil Conservation in the Basin of the Río Grande of San Miguel

About 75 percent of the sediment in the Río San Miguel originates from cultivated lands on the eastern slopes of the San Miguel volcano. Severe erosion is resulting from cropping with sugar cane, corn, and cotton on steep slopes with moderately permeable soils, subject to intense rainfall. At present rates, much of the cultivated land will erode to hardpan within about 25 years. The resulting sedimentation would soon seriously reduce the effectiveness of the Olomega project, in the absence of conservation measures.

Proposals include the construction of 24 km. of access roads, the excavation of diversion channels paralleling these roads, the installation of bench terraces with tile outlets, and associated measures for conservation and forest planting. The project involves treatment of some 7,200 hectares, with an estimated investment cost of ¢5.3 million. Additional data are needed with respect to hydrology, topography, pedology, and agronomy before developing final conservation plans.

Program 10. Development of the Livestock Industry

Livestock production for meat and milk in El Salvador will have to be stimulated considerably if the Nation is to meet the goals for a three-fold increase in output during the next two decades. Correspondingly large increases in the production of pork, poultry and eggs will be more easily attainable, providing supplies of corn and other feedstuffs can be augmented at reasonable prices. Hence, attention at present will focus primarily on the cattle enterprise, especially considering the lengthy nature of the reproductive cycle, which impedes the quick realization of numerical expansion and genetic improvement.

For these and other reasons, the Ministry of Agriculture is currently giving special attention to strengthening its cattle development program. Toward this end, a Working Committee including Dr. Leo Paschal of RRNA was recently appointed by the Minister. The following paragraphs will include a synthesis of the Committee's findings relating to the present situation and possibilities for improvement, before introducing the basic elements of its preliminary development program proposals. Some of these proposals had already been incorporated in a project summary prepared in Sept. 1969 by G.P. Day of the FAO Agricultural Diversification Team.

Present Situation: The total 1969 cattle population of El Salvador is estimated at 1.4 million head. Since work oxen over 2 years of age comprise some 12 percent of total numbers, and since there is only limited differentiation in the breeding of animals producing meat, milk, and draft service, one may say that the country maintains a triple purpose herd. This herd is predominantly derived from native or criollo stock, but Cebú blood has been introduced in crosses where the emphasis has been on beef production, while some Brown Swiss and Holstein blood has been introduced by producers emphasizing milk production.

There are very few specialized dairy herds, and most of the milk supply is obtained by the once-a-day milking of cows with calves at their side. Under these conditions, the lactation period is commonly six.

months or less and few herds produce more than 2,000 liters of milk annually per cow milked.

A distribution of herd numbers and an estimated distribution of cattle numbers according to size of herd, based on the 1961 Census, is as follows:

Herd size class	Number of herds	Number of cattle	Percentage distribution of cattle by size class
		(000)	(percent)
Fewer than 5 head.....	48,319	133	12
5 - 20 "	32,299	355	32
21 - 50 "	4,973	177	16
51 - 200 "	2,361	237	21
More than 200	420	213	19
Totals.....	88,372	1,115	100

According to these estimates, approximately 40 percent of the cattle are in herds of 50 head or more. Approximately two thirds of these larger herds are on farm units of 50 hectares or more, which account for 28 percent of all cattle.

At the other end of the scale are 46,000 subsistence units and small commercial farms of less than 10 hectares, each with one to four head of cattle. An additional 2,300 units with one to four head of cattle are on farms of 10 hectares or more. Many of the units in these two groups have only a yoke of oxen or a family cow and her calf.

Altogether, it is estimated that 53 percent of all cattle are in the 84,000 herds of 50 head or less on units of less than 50 hectares. This leaves 7 percent of the cattle on 2,000 larger farms with fewer than 50 head, and 12 percent of the cattle on 900 farms with fewer than 50 hectares but more than 50 head.

At the time of the 1961 Census, the proportion of cows in milk in relation to all cattle over two years of age was 26 percent on units of 500 hectares or more, about 33 percent throughout most of the range in farm size from 3 to 500 hectares, and only 19 percent on units of less than 3 hectares. Production of market milk is thus of considerable importance on a large share of the farms with the largest herds, as well as in herds of medium size.

Almost all farm units with cattle produce corn and other subsistence crops, and many produce at least one or two other crops for market. Owners of the larger herds, as well as many in the medium size ranges, tend to have business interests other than agriculture. Such individuals commonly reside away from the farm unit, and depend upon a hired manager or caretaker to supervise their farming activities, including the cattle enterprise. (See Section V-A5).

Cattle in El Salvador find their principal source of nourishment by grazing on close to half the total land in farms. According to the 1961 Census, 31 percent of all farmland was in natural pastures 7 percent was in seeded pastures, and 11 percent was identified as descanso (land left to rest without a crop, after having been planted within the preceding five years). Additional areas classified as woodland were probably open to grazing, and crop residues and roadsides are frequently grazed as well. The distinction between natural and seeded pastures, woodland and descanso is probably none too sharp, but the characteristics of the total pasture area range from level irrigated lands of high productivity to large extensions classified as eroded peneplains of low potential or cut-over mountainous lands suited mainly for forestry. (See Section V-A2). If only land reported as natural or seeded pasture is considered, the total pasture area is about 615,000 hectares, and the current average stocking rate is 2.2 head per hectare.

In general, pastures have been subjected to little improvement except for fencing and such clearing as may have taken place in connection with crop production. In the Río Grande Valley near Sonsonate, and in a few

other locations, water has been diverted to provide irrigation of relatively level valley lands by flooding. Elsewhere, many pastures are principally covered with trees, brush, and weeds, and others have suffered from overgrazing and erosion. Use of fertilizer is rare.

Protein supplements and mixed rations are occasionally fed to cows in milk, especially during the dry season, but many herds lack even salt, and sources of water and shade are not always well distributed. Hay and silage are stored for feeding during the dry season to only a very limited extent.

Internal and external parasites and tick-born diseases, infectious pneumonia, and other infectious diseases cause heavy losses to cattlemen. Calf losses are particularly heavy, with an estimated mortality rate during the first year of some 20 percent. The Ministry is attempting to help in controlling tuberculosis and brucellosis, but much still remains to be done and veterinary resources are extremely scarce. Aftosa, fortunately, is not a problem at present in El Salvador. Barren cows, resulting from male or female fertility problems, are present in many herds yet remain undetected for lack of record-keeping procedures.

Given the levels of nutrition, herd health protection, and general management, it is not surprising that performance ratios in meat production tend to be low, even after allowing for the triple-purpose nature of the total cattle herd.

The 1968 extraction rate (number of animals slaughtered plus net exports, as a percentage of the total herd) was 14 percent, as compared with rates of about 40 percent realized in New Zealand and the U.S.A., 28 for Australia, and 22 for Argentina. Of the 186,000 animals slaughtered in 1968, the distribution by classes was as follows:

Cows	45	percent
Oxen	19	"
Steers	20	"
Bulls	12	"
Heifers	3	"
Misc.	1	
	100	percent

Although the slaughter classification reveals a high proportion of old animals (cows and oxen) and almost no representation of young animals such as veal calves, the average carcass weight for animals commercially slaughtered was only 143 kilos, compared with averages of 270 kilos in New Zealand and 280 kilos in the U.S.A. Part of the difference is reflected in the dressing percentage, which is 46 percent for El Salvador, 60 percent for New Zealand, and 62 percent for the U.S.A.

Much more favorable performance ratios have been demonstrated on a few ranches in El Salvador, where steers sold at two years of age are producing carcasses of about 270 kilos, with an estimated dressing percentage of 56 percent. On these ranches, an average of 3 head are grazed per hectare.

If the annual carcass output of beef is divided by the total hectares of pasture, the output per hectare is around 40 kilos. Since the area available for pasture in 1990 will probable be no larger than at present, the output per hectare must increase by more than three-fold during two decades, if the production goals for 1990 are to be realized.

Possibilities for Improvement: The need for expanding crop production by 1990 will leave little margin for diverting El Salvador's level and most productive lands to pasture-instead, some such lands may be shifted from use for pasture to use for cropland. At the other end of the scale, much of the mountainous area and eroded peneplains will be more productive for well managed forests than for grazing. Thus, expanded livestock output must be achieved by measures to increase output per unit of land area and per animal.

In terms of performance ratios, increasing output per unit of land and per animal will be reflected in higher milk output per cow, higher average slaughter weights per head, a higher dressing percentage, younger average age of slaughter steers, a diminishing percentage of bulls and oxen in the total herd as the use of artificial breeding spreads and as motor vehicles and mechanical equipment take the place of work animals, an increase in the number of live calves born per 100 cows, and a reduction in the rates of calfhood and subsequent mortality.

The performance ratios mentioned in the last paragraph will change, of course, only to the extent that changes are made in production practices related to animal nutrition, herd health, selection and breeding, and general management, as well as in the marketing practices which affect weight losses on the way to slaughter. Such changes as these, in turn, will take place only if public policies are such as to provide producers with adequate incentives, knowledge, credit, and marketing opportunities, through a program in which all necessary elements are fully coordinated. The existing Livestock Commission provides a vehicle for assuring such coordination, but some adjustments may be needed to make it more broadly representative of varied interests in the cattle industry, and to assure that the roles of a Technical Committee and an Advisory Council will both be filled.

A more detailed discussion of possibilities for improving production and marketing practices, together with proposed steps for fostering the needed changes, will be presented under three Sub-Programs, respectively related to Improving Ranch Management, Regulatory Activities and Marketing Services, and Financing Livestock Development.

Sub-Program 10.1. Improving Ranch Management

The principal objective of this sub-program is to improve the management capabilities and management performance of the indivudals primarily responsible for decisions affecting results of the livestock enterprise on farms in El Salvador. The term "ranch management" is chosen to emphasize that successful livestock production depends as much upon decisions related to pasture manage-

ment and feed production on the total farm unit as on decisions more closely related to the breeding and care of the livestock herd. However, the desired improvement of managerial capability and practice is not limited to the some 400 units with herds of more than 200 head, which would properly be called "ranches" in the use of the term in English. Much of the same kind of improved managerial capability is needed on the 7,000 crop and livestock farms with 21 to 200 head, and certain improved practices will find applicability on most of the 80,000 remaining farms and subsistence units with small herds or only one or two animals.

The need for improving management capabilities and performance arises because farm operators and managers lack training, information, and motivation for effective execution of such activities as the following:

a) Recognizing deficiencies through observation and use of records;

b) identifying and appraising alternatives in general;

c) taking steps to satisfy nutritional needs of cattle through more effective use of pastures and supplemental feedstuffs;

d) taking steps to protect herd health;

e) identifying and eliminating unproductive animals;

f) improving the genetic potential of the herd;

g) improving the sanitary conditions surrounding the production and shipment of milk;

h) using market information in selling livestock.

Some of the changes which will represent the ingredients for improved performance will be as follows:

a) Eliminating unproductive animals;

b) constructing fences to divide pastures for rotation grazing;

c) eliminating weeds, brush, and excessive trees from pastures;

d) clipping pastures frequently;

e) applying seed and fertilizer where their value can be demonstrated;

f) making more effective use of present irrigation facilities, and constructing new facilities on a limited number of farms (see Adjustment IV, in Section V-B);

g) managing rotation grazing so as to carry one or more fields of standing forage into the dry season;

h) providing more adequate dry season forage through storing hay or silage, and acquiring the necessary additional equipment and structures (see Adjustment V, in Section V-B);

i) making use of new technology for the use of low quality by-products and forages (such as cane tops, rice straw, and coffee pulp) reinforced with molasses, urea, and other supplements, when procedures are more fully worked out through research and test-demonstrations;

j) separating cows with calves from the rest of the herd, and providing for creep feeding of calves;

k) providing adequate amounts of minerals, including salt;

l) drilling wells and making other improvements in water supplies for stock;

m) participating in national programs for controlling endemic diseases;

n) protecting herd health on the individual farm;

o) taking simple steps to improve the genetic

capability of the herd, including more careful selection of bulls and limited use of artificial insemination;

p) controlling breeding periods so as to provide more favorable rearing conditions per calves;

q) constructing or improving stables and other farm buildings, and installing equipment for sanitary production, storage, and shipment of milk;

r) using credit wisely.

The appropriate combination of such changes for any individual farm unit cannot be predicted or recommended in advance--it must be worked out by the individual farm operator and/or his farm manager, taking advantage of such information and technical assistance as can be obtained from publications, extension personnel, credit personnel, veterinarians, commercial representatives, and other sources. Some practices such as providing salt have almost universal applicability, but many, including irrigation, will prove to be appropriate on only a small number of units. The priority for making changes and new investments will also vary among individual farms. Therefore, continuous farm planning is indispensable for achieving successful results in using owned and borrowed resources. Special efforts for developing a comprehensive long-range farm plan will be needed immediately in advance of any large borrowings.

Management capabilities cannot be fully developed overnight--instead, a combination of considerable training, much experience, and many supporting services is needed. Nevertheless, considerable improvement can be expected from even brief training which would alert farm owners and managers to the problems needing study, to the fact that something can be done about these problems, and to the available sources of information. Therefore, it is proposed that a starting point in the sub-program for improving Ranch Management should be the development of a short course, along the lines of Project 10.1.1, presented below. Other supporting activities, such as those for research and education incorporated in the proposal for the National Center of

Agricultural Technology (Project 1.1) will, of course, represent important contributions to Improved Ranch Management. Moreover, training in Improved Ranch Management cannot be fully effective without such complementary measures as those proposed elsewhere for improving livestock marketing practices and facilities, and for making rural credit more readily available.

Project 10.1.1 Short-Course in Ranch Management

This project provides for the development and presentation to various groups of a ranch management short-course, providing concentrated, practical training in solving the problems faced by ranch owners and managers, and by the representatives of educational, credit, and other service agencies who work with them. A special team would be assembled to prepare course materials and make the initial presentations to groups of workers in credit and educational agencies; some of these workers, in turn, would present the course with appropriate variations to their colleagues, to the owners and managers of larger ranches, and gradually certain parts of the course would also be presented to groups of medium-sized and smaller cattle producers, to 4-C members, and to university and secondary students.

Because making improvements in ranch management, especially on the larger units, will often involve considerable use of credit, it is suggested that credit agencies play a leading role in sponsoring the course, in helping to prepare it, and in providing many of the early participants. The Ministry of Agriculture and the Central Bank, for example, might be the initial co-sponsors, and representatives of both private banks and public credit agencies such as ABC and MEGA should collaborate in developing the course. Primary responsibility should rest with a team working full-time, and composed approximately as follows:

1 bank representative having a good background in credit operations and cattle production;

1 livestock specialist with a good general understanding of the cattle industry;

- 1 agronomist with a good understanding of pastures, harvested forage, irrigation practices, and animal nutrition;
- 1 veterinarian well qualified in general cattle health problems as related to ranch operations;
- 1 ranch economist with a good understanding of management principles, planning and accounting techniques, agronomy, and animal husbandry.

Information from other countries as well as from local research and experience should be fully used, and it may be advisable to bring in experienced professionals to review course materials in the later stages of their preparation. At least one or two members of the team should be assigned to prepare and present the course over a continuous period of at least a year. Other members might participate for shorter periods, so that the total inputs during the first year would be 50 man months of the time of Salvadoran technicians and 15 man months of foreign technical assistance personnel, plus a full-time secretary and a driver for a four-wheel-drive vehicle. Thereafter, presentation of the course would be incorporated as part of the regular activity of credit and educational agencies.

The full course would need to be scheduled for approximately ten lecture and discussion periods of at least 2 hours each, plus a full day or more for visiting two or three ranches and other facilities. Some of the principal topics would include the role of management on ranches, the use of farm records, the basics of cattle nutrition, the techniques for improving the production and utilization of forage from pastures, the techniques of producing and using supplementary forage and feedstuffs for the dry season, procedures for protecting herd health, procedures for identifying unproductive animals and for improving the genetic composition of the herd, planning for wise use of credit, loan and collection procedures, and practice in identifying and evaluating management alternatives in respect to a variety of problems.

The first presentation of the course, on a trial basis, should begin no later than the middle of the year,

so that the results could be evaluated and considered in subsequent modification and in additional presentations. The participants for this trial run should include at least one or two ranchers as well as several extension workers and credit specialists, with a total of no more than 10 or 12 trainees. Thereafter, the course could be presented to groups no larger than about 25 individuals, focusing first on representatives of credit agencies and extension workers so that at least 25 of each would be prepared to work full-time thereafter in helping ranchers to develop improved management plans, including provision for the use of the credit needed to put the plans into effect.

Goals for presentation of the course materials would be to reach some 60 or more program leaders during the first year, a total of 300 technicians and program administrators by the end of the second year, and some 3,000 farm owners, managers, workers, and students by the end of five years. At present there are only about 25 professionals in various phases of cattle production working in government agencies.

The cost of developing the course and presenting it during the first year might be wholly or partially absorbed by regular budgets for credit activities, extension, and livestock development, or it might be obtained from a grant or other special funds. An estimated budget follows:

Salvadoran specialists	50 man months	¢ 90,000
Foreign specialists	15 " "	87,300
Bi-lingual secretary	12 " "	7,200
Driver	12 " "	2,400
Four-wheel drive vehicle	one	8,000
Misc. equipment and supplies		10,000
	Total	204,900

Sub-Program 10.2 Regulatory Activities and Marketing Services

Adequate laws and their strict enforcement are of primary importance for establishing an institutional environment favorable to increased production and consumption of meat and dairy products. Much of the

necessary regulatory activity relates to procedures involved in marketing, which are also affected by the available facilities and technology. Hence, it seems appropriate to consider a broad combination of regulatory activities and marketing services under a single sub-program.

The Ministry of Agriculture is fully aware of the need for an adequate legal framework to support the production and marketing of cattle, meat, and dairy products. It is now in the process of reviewing existing laws and in fostering new legislation where needed. The Department of Public Health is cooperating. A list of current laws and regulations which affect the livestock industry has been prepared by the Legal Department of the Ministry.

The current review of legislation has already resulted in progress on such legislation as a meat inspection law; a bill regulating the production, processing, and distribution of milk; and revision of legislation relating to pledging of livestock as collateral for loans. Depending, in part, upon results of present activities, further detailed studies with the help of special consultants may prove desirable.

The revision of legislation and regulatory procedures should lead to such results as the following:

a) The free movement of meat within El Salvador, so that it can be sold anywhere providing it complies with national sanitary and grading requirements;

b) Simplification of the "Carta de Venta" to speed up transfer of title to livestock sold;

c) Improved sanitary control and more economic operation of livestock sales yards and slaughter facilities;

d) Adequate legal protection for creditors whose loans are secured by cattle and other chattels. Enforcement of severe penalties for the unauthorized sale of mortgaged property;

e) Development of appropriate grades and standards for use in marketing livestock, meat, and dairy products in El Salvador;

f) Improved sanitary control in the wholesaling and retailing of meat;

g) Improved sanitary control relating to the production, processing, and distribution of milk;

h) Adequate procedures for inspection and enforcement to assure compliance with such laws and regulations as those mentioned above.

Once an adequate legal and regulatory framework has been developed, major educational efforts will be needed to encourage producers and marketing organizations to comply with and take advantage of the new requirements. Special efforts may be needed in promoting compulsory and/or voluntary programs aimed at eliminating or reducing the incidence of some of the major diseases such as brucellosis and tuberculosis. There will also be need for intensification of service activities in marketing--with more cattle market by grade and by weight, for example, market news activities will become more meaningful and should be expanded. Intensified services to increase the availability and reduce the cost of farm inputs will also be needed. A special case is the need for making superior germ plasm available, partly through artificial insemination, and perhaps partly through contract procurement and distribution of purebred or other bulls.

The need for expanding the Marketing Department within the Dirección General de Economía Agrícola y Planificación of the Ministry of Agriculture, so that it can take a leading part in providing needed marketing services and assist in the planning of needed facilities, has already been noted under Program 3.

Continuous analysis and planning will be needed with respect to new facilities, although the immediate needs with respect to marketing cattle, meat, and dairy products are not extremely large. Current effort toward planning for a model slaughterhouse have already been mentioned under Sub-Program 3.3. This and other private investments in dairy processing and in retail meat and

bulk milk outlets are estimated to total ¢4 million for the 1970-74 period. Although these are expected to be investments by the private sector, some public assistance in planning and obtaining credit may be needed. Investments along the same lines for the 1975-79 period are estimated at only ¢1.9 million. Additional operating capital, of course, will also be needed when these facilities begin to function.

Alternatives with respect to improving the marketing of milk deserve special study before public policies are established and private investments made. It is estimated that only 6.3 percent of total milk production reaches processing plants and only 28 percent of this is pasteurized. Thus the greater part of the fluid milk sold in the country, especially in the outlying sections, is not pasteurized, although the country has six plants with pasteurizing facilities. Lack of refrigeration in homes and in distribution channels tends to encourage the use of powdered milk instead of fluid milk. Much of the powdered milk is imported at present, but the country does have one powdered milk plant and another under construction.

The future possibilities of milk substitutes based largely on vegetable sources also need to be considered in this connection. Changes in public policy with respect to encouragement of expansion of milk production may be necessary in the future if more economical alternatives to milk are developed.

Little doubt can exist, however, that something needs to be done to make limited changes in the facilities and vast improvements in the practices used in marketing the 98 percent of the milk supply which is not pasteurized. Most of this is converted to cream, cheese, and butter or sold in an adulterated form which contains 15 to 20 percent water. Skim milk and whey tend to be wasted. The installation of bulk dispensers for retail milk sales is one step which might help to reduce adulteration and improve sanitary conditions in milk distribution. This would represent only a relatively small amount of private investment, but technical assistance or permissive action may be required.

Table VII-5 Additional Capital Requirements For Marketing Livestock, Meat and Dairy Products
(Thousand of colones, constant 1970 prices)

Type of facility	1970-1974	1975-1979	1980-1984	1985-1990	Total 1970-1990
Dairy processing facilities (private)	1,150	1,150	2,250	2,250	6,800
Bulk milk distribution systems (private)	100		100		200
Facilities for handling livestock at principal concentration points.	70	70	70	70	280
Additional meat packing plants (private)	2,500	500	3,000	6,000	12,000
Meat distribution retail outlets (private)	250	250	500	500	1,500
Total	4,070	1,970	5,920	8,820	20,780

The main public investments proposed to support livestock marketing during the 1970-79 decade are for the development of improved sales-yards for cattle at various assembly points throughout the country. The total investment in such facilities during the decade is estimated at only ¢140,000, but this is a very strategic item in improving livestock marketing practices, and should receive immediate attention along the lines of the following project proposal.

Project 10.2.1. Developing Modern Sales-Yards at Livestock Assembly Points (project in development)

As cattle move from the farm where they originated to consumption centers, they are sold and resold in municipal tiangues along the way. Facilities for unloading, holding, watering, feeding, weighing, and loading in these tianques are almost non-existent. Cattle are sold by the head, enter and leave the tiangue on foot, and lose a considerable amount of weight in the total process. The frequent selling and re-selling of cattle along the way may be the result, in part, of the lack of appropriate facilities for more objective selling procedures and for providing transit feeding without a change of ownership. More research on weight losses is needed, but it would not be surprising to find that they approach 5 percent on a single move.

The present project provides for the construction of approximately five modern sales-yards at some of the principal assembly points along principal marketing routes. The objective would be not only to serve local needs, but also to provide pilot units of various sizes, so as to permit testing of models which could later be duplicated at other points. The Ministry has already indicated its interest in developing three such units, by including them in the current five-year plan.

Each sales-yard would need to provide ramps for loading and unloading cattle, scales, holding pens with arrangements for feeding and watering, and an office for control of operations. Appropriate charges would be made to cover the cost of the services rendered. In some cases public land may be available for construction, while in

others land acquisition may be necessary. A total budget of ¢70,000 is proposed for the 1970-74 period.

Sub-Program 10.3. Financing Livestock Development

Sizeable new investments, both on farms and elsewhere, will be required if the goals of the Livestock Development Program are to be realized. Producers and marketers can naturally be expected to provide part of the additional capital, but much of it will need to be extended as long-term, intermediate-term, and short-term credit by public and private financial institutions as well as by individual lenders.

For this to take place, deficiencies of the institutional lending system will need to be remedied, along lines which have already been noted under Program 4. Not only must new sources of credit be made available, but much more emphasis must be placed on intermediate to long-term credit for farm improvements. The fact that MEGA has been able to make only 286 loans in response to 1,222 applications is suggestive of the problem. Loan procedures need to be related more closely to the needs revealed by individual farm planning, and the mechanics of handling applications and funds need to be simplified. Such changes will require intensive efforts and close cooperation by the Ministry of Agriculture, the institutional lenders, and other interested agencies.

Assuming that a favorable institutional environment can be developed, the need for lending to support improved ranch management during the 1970-79 decade is estimated at some ¢65 million. This estimate is derived from the following assumptions:

a) An increase in annual output of cattle and milk during the decade of ¢72 million, as indicated by the production goals;

b) A marginal capital output ratio of 1.2 to 1;

c) Borrowings equal to 75 percent of the additional investment.

More specifically, with reference to the kinds of changes involved in achieving the indicated gains in output, it is assumed that investments in irrigating pastures and in providing hay and silage for the dry season will be completed up to the full levels specified under Adjustments IV and V in section V-B. These changes would account for an additional output of ¢11.66 million, with a total additional private investment of ¢32.3 million, and additional use of credit estimated at ¢23 million. The marginal capital/output ratio for these two adjustments is about 2.8 to 1, but relatively costly investments are involved, especially insofar as irrigation is concerned.

In addition, it is assumed that a total of 10,000 of the larger producers, including most of those affected by Adjustments IV and V, will make significant investments in improving their pastures through building fences to permit rotation grazing, through providing additional stock watering facilities, and through establishing improved stands of grass. A farm unit with 32 hectares of pasture and 80 head of cattle would be likely to invest around ¢168 per head or ¢425 per hectare in making this combination of improvements, or less if only part of the package were needed. At an average of ¢120 per head for 300,000 head of cattle on the 10,000 units, the total investment would be ¢36 million, of which some ¢28 million would probably be borrowed.

Simple improvements in practices and in the productive potential of the herd, which require practically no new investments, will account for a significant share of total additional output over the decade. The gradual replacement of work oxen by other animals producing more meat per unit of forage consumed, or by cows to produce milk for home consumption on small farms, is an example of one such source of added output. This change can be expected to take place as rapidly as improved feeder roads permit the use of motor transport in place of the ox-cart, as existing tractors are equipped with cultivators, and as small motorized equipment replaces the ox in other tasks.

Another example relates to the efficiencies which can be gained in feeding milk cows, as their productive

potential increases and as limited amounts of concentrates are used to supplement the nutrients provided by forage. Dr. Wade Gregory, in a 1967 report entitled "Examples and Ideas for using Farm Management Analysis in El Salvador", points out that the proportion of total nutrient consumption used for milk production will increase from 12 percent for a cow producing only 1,000 pounds annually to 41 percent for a cow producing 5,000 pounds annually. With limited improvement of productive capability through culling and breeding, and with very modest use of concentrate feeds to supplement pastures, the output of milk could thus be increased fivefold in many herds, without appreciable capital investment.

Other miscellaneous types of investments are estimated at ¢18 million, giving an aggregate additional investment of ¢86 million, with aggregate borrowings of ¢65 million.

The bulk of the ¢65 million of additional credit will be extended to some 10,000 livestock producers with a total herd of 300,000 to 400,000 head. More than half of the credit will probably go to some 3,000 producers with a total of 200,000 head or more.

Under favorable conditions, a credit agent working with close cooperation from a livestock extension specialist and a veterinarian can be expected to assist at least 25 ranchers annually in preparing comprehensive ranch development plans and corresponding loan applications. With 50 such teams at work, a total of at least 1,250 ranchers could be assisted annually. This is approximately the scale of activity needed to make 10,000 loans based on ranch development plans between 1972 and 1979. A part of the total credit needed, of course, will be in small loans not based on such comprehensive planning.

Nearly half the total investments to be made by the 10,000 producers will be in structures, including fences, stock water wells, buildings, and irrigation facilities. Not more than 20 percent of the total should be invested in additional cattle, the bulk of which should be in cattle retained from those raised on the farm. The remainder of the additional investment would represent

increased use of capital for operating expenses and for such improvements as clearing, seeding, and fertilizing pastures.

The estimates presented here are, of course, only preliminary approximations which will need to be refined through a full-scale feasibility study before a loan request can be developed for presentation to an international lending agency. However, the present data strongly suggest that it would be appropriate to proceed with such a feasibility study, as a preliminary to a loan proposal which might also include financing for some of the marketing facility construction proposed for the 1970-79 decade, as well as for certain research, educational, and service activities needed to support the livestock development program, and not provided for otherwise.

As already emphasized, a major loan to support livestock development can be meaningful and worthwhile only as part of a comprehensive and coordinated program in which research and educational activities, a favorable institutional environment with respect to regulatory activities and marketing services, and effective organizations and procedures for extending credit will all play major roles.

The Priorities

In the introductory portion of this chapter it was noted that programs, which tend to be open-ended and implemented through plans developed periodically, are not subject to the same kind of pre-evaluation as projects, which can be fully specified in a quantitative manner before they are initiated. Hence, the primary need here is to specify priorities among the various projects which represent contributions under the various programs of the agricultural sector, and especially among the investment-type projects, which represent large inputs of resources, often involving international financing.

It would not be meaningful to place all such projects in a single hierarchy, inasmuch as many of them must proceed concurrently, under the responsibility of various agencies, using the talents of various kinds of professionals and workers, with financial resources

originating from various semi-independent sources, and with the benefits to be expected from the considerable degree of complementarity among the projects and the available resources. Furthermore, it is necessary to distinguish between the immediate urgency of undertaking an entire project and the urgency of undertaking limited preparatory work as a basis for full implementation of the project at a later date.

Accordingly, the most useful procedure appears to be that of grouping the projects in three classes, delineated as follows:

I. Investment and Related Projects whose implementation should proceed immediately.

II. Investment and Related Projects whose implementation will be urgently needed during the 1970-79 decade, subject to completion of any necessary preparatory action and further evaluation.

III. Other projects of importance.

The remainder of this section will present the results of such a classification, with brief comments on the reasons and conditional requirements. Priority ratings are not implied by the order of presentation within each group.

I. Investment and Related Projects Whose Implementation Should Proceed Immediately

a) Project 1.1 Establishing a National Center for Agricultural Technology. Development of this project is well advanced up to the present, and it is so urgently needed in attaining the goals of the 1970-79 decade and in providing an accumulation of research results basic to attaining the goals of the 1980-89 decade that implementation is not only urgent, but of top priority among the projects in this Class.

b) Project 2.2 Irrigation Development in The Zapotitán Valley. This project is advanced to the point where implementation has been initiated with limited resources. It's significance as a pilot project for a broad program of hydraulic development places it in Class I. To support development of the Zapotitán project and the entire program of irrigation development, an immediate start is also needed on Project 2.1. Research and Test-Demonstration Activities on Privately Irrigated Farms, as well as intensification of efforts for collecting hydrologic data throughout the country.

c) Project 3.1.1. Expansion of IRA Storage Facilities. Already well developed, and involving relatively modest expansion of grain storage facilities, this project will contribute significantly to immediate needs for additional storage.

d) Project 6.1. Reforestation of the Northern Zone, Metapán-Chalatenango and Project 6.2. Reforestation in the Area of the Reservoir 5 de Noviembre. The implementation of these projects will be significant as a means of initiating a much expanded forestry program, and also in terms of reducing erosion which is causing serious damage downstream. The projects will be particularly timely if they can be supported by, and serve as a vehicle for, activities along the lines suggested under the preliminary descriptions for Projects 6.3 Conserving Human and Natural Resources through Forest Development and 6.4. On the Job Training for Technical Personnel and Skilled Workers in Forestry Conservation, through support from the U.S. Peace Corps.

II. Investment and Related Projects whose implementation will be urgently needed during the 1970-79 decade, subject to completion of any necessary preparatory action and further evaluation.

a) Pilot activities and/or feasibility and planning studies under the following hydraulic projects:

Project 2.3 Irrigation and drainage in the Usulután-Vado Marin Area
Project 2.4 Irrigation and drainage in the Sonsonate-Banderas Area
Project 2.5 Development of the Lower Lempa Valley
Project 2.6 Development of the Olomega Area
Project 2.7 Drainage and irrigation in the High Valley Area of Ahuachapán and Santa Ana
Project 2.8 Irrigation for the San Miguel-San Esteban Area
Project 2.9 Development of the Jocotal-San Dionisio Area

The immediate action needed for all of these projects is to proceed with additional feasibility and planning studies as previously indicated, and to proceed with pilot activities as plans reach a stage of adequate preparation. Knowledge gained from such pilot activities will influence the future course of investments needed to contribute to realization of goals for the 1980-89 decade.

b) Project 3.2.1. Constructing a Wholesale Market in San Salvador. Construction of an adequate wholesale market is urgently needed, but it appears, as set forth in section V-C, that needs of the near future are still seriously underestimated. Additional planning is urged to design a facility adequate to meet such needs.

c) Project 3.3 Developing Processing Facilities. At present, this project as a whole consists mainly of several feasibility studies in various stages of progress. As rapidly as these produce results, the implementation of specific investment projects needs to proceed. In a number of cases, it is hoped that the results will contribute significantly to increased foreign exchange earnings.

d) Project 4.1. Formation and Capitalization of an Agricultural Development Bank. Credit for expanded production and marketing activities is an extremely crucial factor in goal attainment. Progress on planning for the formation of this bank is well advanced, but further

TABLE 1

AVERAGE NET INCOME ON LANDS STUDIED IN TAMS REPORT 1/

	Nonirrigated Lands		Irrigated Lands		Periodic Income	
	Per Manzana $	Per Hectare $	Per Manzana $	Per Hectare $	Per Manzana $	Per Hectare $
One Crop	135	193	137	196	2	3
Annual (1.4 crops without irrigation, 2.4 crops with irrigation	189	270	330	470	41	200

TABLE 2

NET INCOME PER MANZANA FROM PRODUCTION OF ONE CROP 1/

	W/o Irrigation Per Manzana	W/Irrigation Per Manzana
Corn		
Av. Prod. (qq/manzana)	50	50
Value at $4.80/qq	$ 240	$ 240
Net income	94	119
	$ 146	$ 121
Beans		
Av. Prod. (qq/manzana)	20	20
Value at $10.40/qq	$ 208	$ 208
Cost of production	67	86
Net income	$ 141	$ 122
Rice		
Av. Prod. (qq/manzana)	25	45
Value at $5.60/qq.	$ 140	$ 252
Cost of production	75	98
Net income	$ 65	$ 154
Cotton		
Av. Prod. (qq/manzana)	12	12
Value at $32.00/qq.	$ 384	$ 384
Cost of production	220	220
Net income	$ 164	$ 164
Average for One Crop		
Per manzana	$ 132	$ 138
Per hectare	190	199

1/ For well developed lands, good seeds, fertilizers, good management. Costs do not include reserves, taxes, land development or irrigation water costs.

TABLE 3

RIO JIBOA IRRIGATION PROJECT

Annual supply of water in dry season	
Ilopango Reservoir	39,000,000 cu. m.
Natural runoff	8,000,000 cu. m.
Total	47,000,000 cu. m.
Main Canal	
Length	10 km.
Capacity at diversion works	6.5 cu. m./sector
Capacity at end (discharge into Rio Comalapa)	1.3 cu. m./sector
Principal branch canals	
Total number	5
Length of each one	4 km.
Capacity of each branch	1.3 cu. m./sector
Farm diversion canals	average 1/km.
Area Served	
Total area served by branch canals	4,000 ha.
Area irrigated each year	
Pastures irrigated for 6 months	500 ha.
Crops irrigated for 4 months	2,500 ha.
Total	3,000 ha.
Cost	
Total cost of installation	$930,000
Capital cost per hectare irrigated	310
Annual Cost	
Amortization - 35 years at 5%	$ 56,800
Operation and maintenance	46,500
Cost per hectare	34.45
Cost per cubic meter	$ 0.0024
Break-down of total cost of installation:	
Ilopango regulating structure - 141 cf/s capacity	$100,000
Diversion structure above the mouth of the Rio Sepaquiapa, 1 or 2 meter crest height	324,000
Main canal, 10 km. from Rio Sepaquiapa to Rio Comalapa on 30-meter contour, 6.5 cu. m./sector reduced to 1.3 cu. m./sector	116,000
5 secondary canals, about 1.5 km. spacing	375,000
Right-of-way	15,000
Total estimated cost	$930,000

TABLE 4

RIO LEMPA IRRIGATION PROJECT

Item	Area Hectares	Capital Investment ($)	Annual Costs Total ($)	Annual Costs Per Hectare ($)
Drainage, gravity, east	9,600	2,520,000	202,000	21
Drainage, gravity, west	9,000	3,105,000	234,000	26
Drainage, pump, west	3,000	1,180,000	211,000	70
Drainage, pump, east	2,100	1,340,000	135,000	64
	23,700	8,145,000	782,000	33 (av.)

TABLE 5

RIO LEMPA IRRIGATION PROJECT

COSTS OF WATER DELIVERY TO THE FARMS

Item	Area (Hectare)	Capital Investment $	Annual Costs	
			Total ($)	Per Hectare ($)
Diversion dam	-	9,300,000	569,000	-
Irrigation, gravity, west	14,600	9,225,000	645,000	44
Irrigation, gravity, east	13,400	7,375,000	525,000	39
San Marcos Pump	1,100	935,000	125,000	114
Santa Cruz Pump	2,800	2,650,000	350,000	125
Jiquilisco Pump	6,500	6,315,000	810,000	125
	38,400	35,800,000	3,024,000	79 (Aver.)

TABLE 6

NET INCOME FROM RIO LEMPA IRRIGATION AND DRAINAGE PROJECT

Item	Total Project	Gravity Drainage Only	Pump Drainage Only	Gravity Irrigation Only	Pump Irrigation Only
Area (Hectares)	38,400	18,600	5,100	28,000	10,400
Cost of the project works:				1/	
Total investment	$43,945,000	5,625,000	2,520,000	25,900,000	9,900,000
Per hectare ($)	1,140	302	494	925	952
Annual costs ($)	3,806,000	436,000	346,000	1,739,000	1,285,000
Per hectare ($)	99	23	68	62	124
Annual net income from production, per hectare:					
Project ($)	470	270	270	470	470
Previous works ($)	187 2/	135	135	270 3/	270
Increase ($)	283	135	135	200	200
Increase in annual costs per hectare:					
Project ($)	99	23	68	62	129
On farm ($)	20	10	10	10	10
Total ($)	119	33	78	72	139
Net Gain ($)	164	102	57	128	61

1/ Includes total cost of diversion dam although said dam also serves for pump irrigation operations.

2/ Weighted average: 14,700 dry hectares at $270 and 23,700 hectares (undrained) at $135.

3/ Assuming necessary drainage will be supplied.

TABLE 7

RIO LEMPA IRRIGATION PROJECT

Principal Crop	Areas Hectares	Annual Production in qq. (1000's)* Corn	Cotton	Rice	Beans	Milk
Corn	13,400 (2)	1,900	-	- (4)	155	-
Cotton	9,600 (1)	685 (1)	165	- (4)	110	-
Rice	5,800 (1)	415	- (1)	375 (1)	165	-
Beans	5,800 (1)	415	-	- (2)	330	-
Pasture	3,800	-	-	-	-	190
Totals	38,400	3,415	165	375	760	190

* Numbers in parentheses indicate the number of harvests per year.

TABLE 8

PLAN I. DETAILS OF OLOMEGA LAGOON - WITH LEVEE SYSTEM

Elevation (meters)	Storage Capacity Above 59 Meter Contour (cu.m.)
59	0
60	17,000,000
61	34,000,000
62	51,000,000
63	68,000,000
64	85,000,000
65	100,000,000

Cost Estimate:	
Principal levees	$ 770,000
Seal	1,080,000
Diversion dam and regulating structure	940,000
Pump installations	200,000
Access canals and levees	1,470,000
Exit canal	1,420,000
Total	$ 5,880,000

PLAN II. DETAILS OF OLOMEGA LAGOON - WITHOUT LEVEE SYSTEM

Elevation (Meters)	Area (sq.km.)	Storage Capacity Above 59 Meter Contour (cu. m.)
59	17.0	0
60	18.3	17,700,000
61	19.3	36,500,000
62	19.9	56,000,000
63	22.3	77,200,000
64	24.4	100,000,000
65	28.1	126,000,000

Cost Estimate:	
Canal and access levee	$ 1,470,000
Outlet canal	1,420,000
Diversion dam and control works	940,000
Relocate people and railroad	150,000
	$ 3,980,000
Estimated value of flooded lands	320,000
Value of damaged lands	300,000
Total	$ 4,610,000

TABLE 9
OLOMEGA PROJECT

COST ESTIMATE FOR IRRIGATION SYSTEM FOR 10,000 HA.

Installation of diversion works	$	200,000
Principal canals		390,000
Pumping plants		380,000
Distribution system		1,019,000
Channel improvement		300,000
	$	2,280,000

TABLE 10
OLOMEGA PROJECT
COMPARISON OF VARIOUS IRRIGATION SCHEMES

	(Cost ($))	
	Total	Per Ha.
A. Initial development of 2,500 hectares Direct diversion from unregulated stream flow		
Capital cost	960,000	380
Annual cost	106,000	42
B. Plan II - Storage in Olomega Lagoon		
Capital cost - storage and canals	3,980,000	
Irrigation - 10,000 hectares	2,280,000	
Sub-total	6,260,000	620
Damages to land	630,000	
Total	6,890,000	680
Annual cost	734,000	73
C. Storage plan for upper river		
Capital cost - storage and canals	5,370,000	
Irrigation - 10,000 hectares	2,280,000	
Total	7,650,000	760
Annual cost	855,000	85
D. Plan I - Storage in Olomega Lagoon		
Capital cost - Storage and canals	5,880,000	
Irrigation - 10,000 hectares	2,280,000	
Total	8,160,000	810
Annual cost	906,000	90

TABLE 11

RESUME OF THE WORKS RECOMMENDED FOR DETAILED STUDY - RIO GRANDE DE SAN MIGUEL

	A Initial Development 2,500 Ha.	B Olomega Lagoon Plan II	C Upper Area Storage	D Olomega Lagoon Plan I
Total ha. irrigated	2,500	10,100	10,100	10,100
Total ha. beneffited	2,500	10,100	10,100	10,100
Total estimated costs*				
Capital costs of works	960,000	6,890,000	7,650,000	8,160,000
Annual costs	160,000	734,000	855,000	906,000
Costs per hectare				
Capital costs	380	680	760	810
Annual costs**	42	73	85	90
Net gain to farmer (per ha.)	138	107	95	90
Income increase/hectare	180	180	180	180
Total income increase	450,000	4,550,000	4,550,000	4,500,000
Relation between income and annual costs of the works	4.3/1	2.5/1	2.1/1	2.0/1

* Including $300,000 for channel improvement of Rio Grande and its tributaries.

** Including interest, amortization, operation, and maintenance

TABLE 12

RIO GRANDE DE SAN MIGUEL - PLAN A

POTENTIAL PRODUCTION FROM 2,500 HECTARES UNDER IRRIGATION

Primary Crop	Annual Production Capacity in qq*							
	Hectares		Cotton		Corn		Rice	
Cotton	1,400	(1)	24,000	(1.4)	140,000		-	
Corn	800		-	(2.4)	135,000		-	
Rice	300		-	(1.4)	30,000	(1)	19,000	
Total	2,500		24,000		305,000		19,000	

* Numbers in parenthesis indicates number of harvests per year.

TABLE 13

COST AND ECONOMIC ASPECTS OF THE ZAPOTITAN RECLAMATION PROJECT

Channel improvements - Rios Chuchucato and Colon	$	85,000
Channel improvement - Rio Talnique		130,000
Channel improvement - Rio Copapayo		25,000
Drainage ditches for 1,700 hectares		153,000
Bridges and drainage crossings		75,000
Rights-of-way		22,000
Total	$	490,000
Capital cost/hectare drained	$	288
Interest and amortization, 35 years at 5%, annual cost	$	30,000
Operation and maintenance, annual cost	$	17,000
Total annual costs	$	47,000
Annual cost per hectare drained	$	27.60

TABLE 15
GRONTMIJ STUDY - ZAPOTITAN
CHARACTERISTICS OF THE AREA FOLLOWING FLOOD CONTROL, DRAINAGE, AND IRRIGATION INSTALLATION

Zone No.	Net Area Ha	Net Area Manz.	Characteristics
I	180	250	Recovered swamp zone, moisture conditions favorable during the dry season; cultivation system must take into account the still existing although reduced possibility of flooding, especially in the lower parts.
II	370	530	Good artificial drainage, no irrigation but natural water supply sufficient to permit well-planned cultivations in the dry season.
III	2790	3990	The total area may be subdivided into:
a	930		Good natural drainage, intense irrigation by field ditches from surface flow during the dry season
b	1790		Good artificial drainage, additional irrigation by infiltration from river run-off
c	70		Good natural drainage, irrigation from an existing well
IV	900	1290	Good natural drainage, no irrigation
TOTALS:			
	4240		Net Project
	360		Roads, ditches, laterals, etc.
	4600		Gross project
			Recommended Crops
I			Pasture grass in the lower areas with production of 100 tons/mza. Could be rotated with rice and some vegetables, but this would be the exception rather than the rule.
II			Rice, pasture grass, vegetables, corn beans, horticulture in the higher areas
III			Corn, beans, tubers, vegetables, sugar cane, plaintain, bananas, citrus.
IV			Citrus and other fruits.

TABLE 16
GRONTMIJ STUDY - ZAPOTITAN
DRY SEASON FLOW AND IRRIGATION UNITS

Name of River	Dry Season Flow Liters/Sec.	Number Irrigation Unit	Number of 80 La. Lots	Total Areas Ha.	Total Water Requirements Liters/Sec.
Belen. Pital					
Gravity Canal	120	I	3	105	104
Colon	220	II	4	286	150
Chuchucato	340	III	8	448	194
		IV	8	442	217
Talnique	360	V	3	251	123
		VI	6	313	176
Rio Frio	140	VII	4	198	70
Copapayo	200	VIII	6	405	197
Santa Teresa	100	VIII	2	171	90
Las Canas	340	VIII	-	40	12
	1820			2659	1333

TABLE 11
GRONTMIJ STUDY - ZAPOTITAN

PRODUCTION PLANS FOR THE FOUR AREAS, TYPICAL FIVE MANZANA FARM

Area I - Dairy Exploitation

Gross Income:		
Milk: 25 cows: 150,000 pounds of milk at ¢0.07/lb	¢	¢ 10,500
Hay: 30 tons (1200 bales) at ¢1.50/bale (less ¢300 for mowing, pressing etc.)		1,500
Meat: Compensation for amortization of cattle		-
Total Gross Income		¢ 12,000
Total Costs:		
Forage - 600 cwt at ¢6.50/cwt		3,900
Fertilizer		500
5% interest on capital (25 cows at ¢800)		1,000
Amortization permanent improvements (¢18,000 at 10%)		1,800
Hired labor		1,000
Other costs		150
Total Costs		¢ 8,350
Total net income 1/ (¢12,000 - ¢8,350)		¢ 3,650
Total net income 1/ per manzana		700
Total net income 1/ per manzana (Rice)		200
" " " " " (Beans)		150
" " " " " (Corn)		100
" " " " " (Vegetables)		1,500

Area II - Optimum Plan

0.5 manzana for canals	¢	
0.5 " " onions		940
1.0 " " vegetables (2 crops/year)		3,000
3.0 " " sugar cane		2,100
	¢	6,040
Net income 1/ /manzana	¢	1,208

Area III - Optimum Plan

0.5 manzanas for canals		
0.5 " " onions	¢	940
0.2 " " vegetables (2 crops/year)		600
0.8 " " potatoes rotated with vegetables		1,688
3.0 " " citrus		4,986
	¢	8,214
Net income 1/ /manzana		1,643

1/ Before deduction of land rent and amortization charges.

Area IV - Optimum Plan

Practically the same as for Area III except for one crop per year

Net income/manzana	¢	700

TABLE 18
GRONTMIJ STUDY - ZAPOTITAN
ESTIMATE OF NET INCOME AFTER IRRIGATION, DRAINAGE, ETC.

No.	Area Manzanas	Size of Parcel Manzanas	Average Net Income Per Parcel	Average Net Income Per Manzana
I	250	5	¢ 3,500	¢ 700
II	530	5	5,000	1,000
III	3,990	5	7,000	1,400
IV	1,290	5	3,500	700
	6,060		¢ 5,900	¢ 1,180

TABLE 19
GRONTMIJ STUDY - ZAPOTITAN
ESTIMATE OF NET INCOME BEFORE IRRIGATION, DRAINAGE, ETC.

No.	Area Manzanas	Average Potential Net Income Per Manzana	Total Income
I	2,874	¢ 350	¢ 1,005,900
II	1,317	¢ 400	526,800
III	1,004	¢ 600	602,400
IV	1,001	¢ 400	400,400
	6,196		¢ 2,535,500

TABLE 20
GRONTMIJ STUDY - ZAPOTITAN

CREDIT REQUIREMENTS FOR 5 MANZANA LAND PARCEL

1.	Structural improvements - long term credit	
	a. Irrigation and drainage	¢ 1,500
	b. Living quarters	2,500
	c. Barn, sheds, and storage buildings	600
2.	Physical improvements - medium term credit	
	a. Land leveling (20% of area)	200
	b. Miscellaneous - (trees, etc.)	100
3.	Farming equipment - medium term credit	
	a. Traction equipment (oxen or trattors)	600
	b. Carts or wagons	500
	c. Fruit trees, poultry, etc.	100
4.	Operating costs - short term credit	
	a. Fertilizers, pesticides, seeds, etc.	500
	Total initial credit	¢ 6,600

TABLE 21
GRONTMIJ STUDY - ZAPOTITAN
AMORTIZATION PLAN OF CREDITS FOR A 5 MANZANA LAND PARCEL

(COLONES)

1	2	3	4	5	6	7	8	9	10	11	12	13
	Loans				Capital Class as shown in Table No. 24							
Year	Initial Loan	Latter Class	Loans Amount	Interest	4.a 500	3.c 100	3.a.b 1100	2.a.b 1.a 1800	1.c. 600	1.b 2500	Total (6,7,8, 9,10,11)	Amortization 12, 5
1	6600			330	500						500	830
2	6100	4.a	400	325	400	100					500	825
3	6000	4.a	300	315	300		220				520	835
4	5780	4.a	200	299	200		220	180			600	899
5	5380	4.a.	100	274	100		220	180	40		540	814
6	4940			247			220	180	40		440	687
7	4500			225			220	180	40		440	665
8	4060	3.a.b.	400	223			80	180	40	100	400	623
9	4060			223			80	180	40	100	400	623
10	3660			183			80	180	80	100	440	623
11	3220			161			80	180	80	100	440	601
12	2780			139			80	180	80	100	440	579
13	2340			117				180	80	100	360	477
14	1980			99					80	200	280	379
15	1700			85						300	300	385
16	1400			70						300	300	370
17	1100			55						300	300	355
18	800			40						300	300	340
19	500			25						300	300	325
20	200			10						200	200	210

TABLE 22
GRONTMIJ STUDY - ZAPOTITAN
CAPITAL INVESTMENT REQUIRED

(COLONES)

	5% Interest During 5 yr. Construction Period	
	Interest Excluded	Interest Included
Flood Control	¢ 3,066,000	¢ 3,729,000
Roads	1,707,000	1,959,000
Irrigation	778,000	873,000
Drainage	720,000	842,000
Land Recovery	460,000	483,000
Total Capital Investment	¢ 6,731,000	¢ 7,886,000

TABLE 23
GRONTMIJ STUDY - ZAPOTITAN
ANNUAL COSTS

(COLONES)

Item	Interest & Amortization	Operating Costs			
		Maintenance	Administration	Operation	Total
Flood control	¢217,330	¢17,600	¢ 3,750		¢238,680
Roads	114,170	35,100	7,500	-	156,770
Irrigation	56,800	8,800	1,500	4,000	71,000
Drainage	54,780	11,250	2,250	-	68,280
Reclamation	31,430	-	-	-	31,430
Total	¢474,510	¢72,750	¢15,000	¢ 4,000	¢566,260

TABLE 24
GRONTMIJ STUDY - ZAPOTITAN
PRO-RATING OF ANNUAL COSTS

(COLONES)

Participant	Interest & Amortization	Maintenance	Administration	Operation	Total
State	¢ 362,930	-	-	-	¢ 362,930
Land owner	54,780	63,950	13,500		132,230
Water users	56,800	8,800	1,500	4,000	71,100
Total	¢ 474,510	¢ 72,750	¢15,000	¢ 4,000	¢ 566,260

TABLE 24A
GRONTMIJ STUDY - ZAPOTITAN
SUMMARY OF COSTS AND BENEFITS

Total Capital Investment	¢ 7,886,000
Farm Development Costs 6060 Manzanas at ¢900/manzana	5,454,000
Total Investment Costs	¢13,340,000
Total Annual Net Income After Improvements	¢ 7,194,000
Total Annual Net Income Before Improvements	2,535,500
Increase in Annual Net Income	4,658,500
Capital/Output Ratio is	2.9 : 1

If the development of the swamp area is considered alone, the resulting capital/output ratio is 2.7 : 1

TABLE 25
GRONTMIJ STUDY INVESTMENT SCHEDULE
(¢.000)

Item	Year				
	First	Second	Third	Fourth	Fifth
Flood control	¢ 1,105	¢ 1,022	¢ 754	¢ 185	
Roads	277	221	358	557	¢ 294
Drainage	96	187	183	254	-
Irrigation	-	177	133	231	237
Reclamation	-	-	-	-	460
Annual	¢ 1,478	¢ 1,607	¢ 1,428	¢ 1,227	¢ 991

TABLE 26
GRONTMIJ STUDY - ZAPOTITAN

PROPOSED GOES SUBSIDIES FOR THE ZAPOTITAN PROJECT

Range of Land Unit Size (ha.)	Number of Units	Total Area (ha.)	Total Cost (Colones)	Government Subsidy %	Government Subsidy (Colones)	Owner's Cost Per Hectare (Colones)
0 - 5	163	512	¢ 734,008	50	¢367,004	¢ 716.80
5 - 20	71	683	979,156	40	391,662	¢ 860,16
20 - 50	17	477	683,832	20	136,766	¢1,146.88
50 - 100	6	484	693,867	10	69,387	¢1,290.24
100 plus	5	2,378	3,409,125	0	-	¢1,433.61
	362	4,534	¢ 6,499,488		¢964,819	

TABLE 27
IAGS/NRD STUDY - ZAPOTITAN
Total Project Costs (Revised)

Flood Control	₡ 2,968,110
Roads	1,246,890
Irrigation	681,595
Drainage	572,285
Swamp Reclamation	901,320
Miscellaneous (5% of construction)	305,500
Contingencies (20%)	1,274,250
Engineering and Administration (12%)	916,000
Construction supervision (8%)	611,000
Legal Expense (20% of land cost)	63,000
Sub-total	₡ 9,539,950
Associate Costs (4,200 h. at ₡200)	848,000
Total	₡ 10,387,650

TABLE 27A
IAGS/NRD STUDY- ZAPOTITAN
Total Annual Costs Benefits and Benefit/Cost Ratio (Revised)

Annual Maintenance Costs:

Flood Control		₡ 24,000
Roads		45,200
Irrigation		16,600
Drainage		20,200
	(1)	₡ 106,000
Annual Operation Costs	(2)	₡ 60,000
Annual Capital Costs (Amortization and Interest Payments)	(3)	₡ 508,000
Total (1 + 2 + 3)		₡ 674,000
Total Equivalent Annual Benefit		1,515,000
Associated Annual Costs		96,000
Net Equivalent Annual Benefit		₡ 1,419,000
Annual Costs		674,000

Benefit/Cost Ratio:

₡ 1,419,000/₡674,000 = 2.1 : 1

TABLE 28

IAGS/NRD STUDY- ZAPOTITAN

Annual Production costs

	Total Area Manzanas	Total Production qq.	Price (Colones/qq)	Total Volume (Colones)	Production Costs (Colones)	Net Value (Colones)
Without Project Improvements (Actual)						
Corn	1,793	41,239	9	₡ 371,151	₡ 389,081	₡ 17,930
Rice	1,928	46,272	15	694,080	651,664	42,416
Beans	2,238	40,284	20	805,680	556,031	249,649
Pasture	1,221	-	410.90	501,709	374,310	127,399
Garden	1,814	-	1,470	2,666,580	1,806,671	859,909
	9,094			₡5,039,200	₡3,777,757	₡1,261,443
With Project Improvements (Hypothetical)						
Corn	2,915	139,920	9	₡1,259,280	₡ 833,690	₡ 425,590
Rice	880	31,680		475,200	305,580	169,620
Beans	1,677	40,248		804,960	480,511	324,449
Pasture	980			479,386	300,439	178,947
Onions	90			132,300	89,636	42,664
Potato	545			801,150	542,798	258,352
Tomato	690			1,014,300	687,213	327,087
Cabbage	125			183,750	124,495	59,255
Peppers	90			132,300	89,636	42,664
Others	293			430,710	291,816	138,894
Tobacco	545	8,109	102.18	828,577	537,370	291,207
Sugar Cane	800	57,104 Tons	19.17 Tons	1,094,683	821,480	273,203
Citrus	300			282,150	163,167	118,983
Yucca	400	91,200	5	456,000	253,204	202,796
Hybrid Corn		3,750	35	131,250		
Seed	150	3,750	39	33,750	105,000	60,000
Plantain	100	80,000 Stems	1.25	100,000	44,281	55.719
	9,580			₡8,639,746	₡5,670,316	₡2,969,430

TABLE 28A

IAGS/NRD STUDY Gain in Net Annual Production

Value of Present Agricultural Productions

Total	₡5,039,200	
Input Costs	3,777,757	
Net	1,261,443	₡1,261,500

Value of Agricultural Production after Project Improvements

Total	8,639,746	
Input Costs	5,670,316	
Net	2,969,430	
		₡2,969,500

Gain in net annual production values ₡1,708,000

TABLE 29
HARZA - ZAPOTITAN
Total Project Investment, Benefits And Income

Stage I:	
Flood Control and major drainage	₡ 3,422,000
Access roads	2,476,000
	₡ 5,898,000
Stage II:	
Irrigation	₡ 3,994,000
Secondary drainage, collection system, and trial farms	678,000
	₡ 4,672,000
Maintenance and Equipment	
Equipment	₡ 246,000
	30,000
	₡ 276,000
Total	₡10,846,000

This estimate includes costs for construction by a contractor, 15% for engineering and administration, and interest during the construction period.

Annual Costs:	
Stage I	₡ 398,000
Stage II	542,000
	₡ 940,000

Annual Benefits (Net)	Stage I	Stage II	Total
Direct	₡ 598,000	₡ 1,387,000	₡ 1,985,000
Indirect and Public	484,000	1,078,000	1,562,000
Total	₡1,082,000	₡ 2,465,000	₡ 3,547,000

Benefit/Cost Ratio

	Stage I	Stage I and Stage II
Direct	1.5	1.9
Total	2.7	3.6

Annual net farm income without the project	₡ 1,914,000
Annual net farm income after Stage I	2,734,500
Annual net farm income after Stage II	4,298,400
Net remaining after deduction farm living allowance	
Stage I	₡ 165/ha.
Stage II	₡ 457/ha.

TABLE 30
HARZA - ZAPOTITAN
Summary of Land Classifications and the Improvements Expected

Land Class	Present Condition (ha.)	With Drainage and Reclamation (ha.)
1	358	358
2	515	2,375
3	324	1,620
4	-	391
5	3,115	18
6	450	-
	18	18
	4,780	4,780

TABLE 31
HARZA - ZAPOTITAN

Projected Average Annual Crop Yields (Per Hectare)

Crops	Unit	Present Yields	Projected Yields: Without Project	With Drainage	With D. & Irrigation	Potential Yields
Corn	Kgs	1,200	1,500	2,750	3,000	3,500
Beans	Kgs	1,040	1,180	1,480	1,600	2,000
Rice	Kgs	1,800	2,100	2,300	2,300	2,800
Sugar Cane	Ton	95	100	110	115	120
*Vegetables	Kgs	5,000	7,700	8,700	9,000	10,000
Pasture	AUM	38	40	45	60	75
Sorghum	Kgs	Neg**	Neg	1,500	3,000	3,500
Tobacco	Kgs	Neg	Neg	800	1,000	1,200
Citrus	Box	-	-	-	400	500

* Average for tomatoes as representative of all vegetables
** Negligible amounts produced at present

TABLE 32
HARZA - ZAPOTITAN
Projected Annual Agricultural Production

Crop	Present Hectare	Present Production Tons	Projected Production W/Drainage Only Hectare	Projected Production W/Drainage Only Tons	Projected Production W/Drainage & Irrigation Hectare	Projected Production W/Drainage & Irrigation Tons
Corn	1,170	1,404	1,955	5,376	2,375	7,125
Beans	1,470	1,530	1,125	1,665	1,300	2,080
Rice	1,040	1,872	520	1,196	1,080	2,484
Vegetables	1,170	5,850	1,295	11,266	1,945	17,505
Pastures	870	119,000	820	118,080	650	140,400
Sugar	130	12,350	130	14,300	215	24,725
Sorghum	*	-	390	585	650	1,950
Tobacco	*	-	215	175	215	215
Fruit	*	-	*	-	430	9
Total	5,850		6,450		8,860	

* Small amount produced

TABLE 33
HARZA - ZAPOTITAN
Projected Increase of Production

Project Situation	Total Production 1,000 Kgs.	Increase %
Present Production	21,006	-
Projected Production w/o Project	27,683	20
Projected Production w/drainage and Flood Control, Stage I	34,388	49
Projected Production w/drainage, Flood Control, and full irrigation, Stage II	55,878	142

TABLE 34
HARZA - ZAPOTITAN
Family Living Allowance (₡)

Item	Unit	Without Project	Stage I	Total Project
Size of farm	Hectare	5.0	5.0	5.0
Net cultivated area	Hectare	4.85	4.85	4.85
Family Labor requirements	Man-day	550.00	550.00	550.00
Family living allowance:				
Labor Income 1/	Colones	1,375.00	1,375.00	1,375.00
Return to Management 2/	Colones	200.00	274.00	449.00
Value of farm privileges	Colones	446.00	493.00	661.00
Total per farm	Colones	2,021.00	2,142.00	2,485.00

1/ Equal to labor income of ₡2.50 per day
2/ Based on five percent of net farm income

TABLE 35
HARZA - ZAPOTITAN
Repayment Capacity for A 5 Hectare Farm

Item	Without Project	Stage I	Stage II
Net income (₡)	2,149	3,068	4,824
Family living allowance (₡)	2,021	2,142	2,485
Payment capacity (₡)	128	926	2,339
Increased payment capacity			
Per farm	-	798	2,211
Per hectare	-	165	457
Total project		712,700	1,974,200

TABLE 36
HARZA - ZAPOTITAN
Revised Project Budget: Total Capital Investment, Costs and Benefits.

Flood control	₡ 2,895,000
Drainage	1,205,000
Access roads	2,476,000
Irrigation	2,890,600
Maintenance equipment and building	335,000
Total	₡ 9,801,000
On-farm investment cost increased to	₡ 1,417,000
Annual costs increased to	1,012,000
Annual Net Benefits	
Direct	₡ 1,953,000
Indirect and Public	1,627,000
Total	₡ 3,580,000
Economic Justification:	
Direct benefits: costs	1.9 : 1
Total benefits: costs	3.5 : 1

TABLE 37
HARZA - ZAPOTITAN
Benefit:Cost Ratio for Farm Operators (Without Roads)

	Annual Totals		Benefit/Cost Ratio
	Benefits	Costs	
Flood control and drainage			
Direct benefits	597.6	573.3	1.04 : 1.0
Total benefits	1,081.3	573.3	1.87 : 1.0
Irrigation			
Direct benefits	1,355.0	436.4	3.1 : 1.0
Total benefits	2,498.0	436.4	5.7 : 1.0

TABLE 38
UNSF/FAO - SAN MIGUEL
Water Budget for San Miguel Basin - Climatic Year 1962

	Upper Basin	
Precipitation	1800 mm.	100.0%
Storm runoff	36 mm.	2.0%
Evapotranspiration	892 mm.	49.6%
Deep infiltration	872 mm.	48.4%
	Lower Basin	
Precipitation	1780 mm.	100.0%
Storm-off	150 mm.	8.4%
Evapotranspiration	880 mm.	49.4%
Infiltration	750 mm.	42.2%
		or
		483.6 Mcm.

TABLE 39
UNSF/FAO - SAN MIGUEL
Estimated Drilling Costs (US$)

Well Type (cu.m./hr.)	Hole Dia. (ft.)	Depth (ft.)	Cost per ft.	Contingency 10% ft.	Cost per well	No. of wells	Grand Total
300	20	305	12.50	1.25	4,193.75	85	336,468
150	18	305	12.00	1.20	4,026.00	55	221,430
100	18	305	12.00	1.20	4,026.00	30	120,780
							698,678

TABLE 40
UNSF/FAO - SAN MIGUEL
Estimated Pumping Costs (US$)

Prime	Cost of Plant	Fixed Cost Per Year	Fixed Cost per cm./ha.	Operating Cost per cm./ha.	Total Pumping Costs per cm./ha.
Electric	13,360	1,377	0.300	0.444	0.744
Diesel	15,503	1,666	0.363	0.565	0.928
Gasoline	14,213	1,604	0.349	1.284	1.633
Propane	14,364	1,546	0.337	1.609	1.846

TABLE 41
UNSF/FAO - SAN MIGUEL
Cost per Meter Length of Lined and Unlined Canals of Small to Medium Conveyance Capacity

Type of Lining	Thickness of Lining (in.)	Conveyance Capacity Cu.m./sec.	Cost per Meter of Length ($)
Unlined earth canal	-	25	0.60
Thick compacted earth	12 - 18	4.85 to 29.2	4.30 to 4.60
Shotcrete or Gunite	1.5 - 3.0	0.60 to 1.20	4.50 to 13.00
Unreinforced Concrete	2.0 - 3.5	2.90 to 3.50	17.70 to 26.90

TABLE 42
UNSF/FAO - SAN MIGUEL

Requirements for Production Well Program, Lower San Miguel Valley

Well	Total No. Required	Drilled Hole Size	Casing Size O.D.	Casing Blank ft.	Requirement Perforated ft.	Slot Opening in.	Gravel Required cu.m.	Gravel Size mm.
300	85	20"	14"	11,720	13,780	3/16	1,200	4-7
150	55	18"	12"	4,827	11,673	1/8	570	2-5
100	30	18"	12"	1,000	7,200	1/8	330	2-4

TABLE 43
UNSF/FAO - SAN MIGUEL
Estimated Costs of Production Well Program

Well Capacity cu.m./hr. gpm	No. of Weeks	Drilling Costs $	General Costs $	Casing Costs Blank $	Casing Costs Perforated $	Pumping Plants Electric $	Pumping Plants Diesel	Pumping Plants Gasoline	Pumping Plants Propane
300									
1,320	85	356,468	12,000	82,040	115,752	700,508	901,981	771,870	782,046
150									
660	55	221,430	5,700	39,762	135,886	300,027	406,881	349,980	360,055
100									
440	30	120,780	3,300	-	140,050	140,050	194,390	163,650	169,100
Total	170	698,678	21,000	121,802	251,638	1,140,585	1,503,252	1,285,500	1,311,201
				373,440					
Total Program Costs						2,233,703	2,596,370	2,378,618	2,404,319

TABLE 44
UNSF/FAO - SAN MIGUEL

SUMMATION OF COSTS, PROPOSED WELL IRRIGATION SCHEME WITH COMPARISON OF EXPENDITURES FOR FOUR SOURCES OF POWER (In U.S. Dollars)

		Electric	Diesel	Gasoline	Propane
1. Project Investment, per well					
Drilling		4,110	4,110	4,110	4,110
Casing		2,197	2,197	2,197	2,197
Gravel		124	124	124	124
Pumping Equipment		6,709	8,852	7,562	7,713
Pump House and Foundation		220	220	220	220
Main Water Distribution Lines		2,212	2,212	2,212	2,212
	Total	15,572	17,715	16,425	16,576
2. Annual Cost, per average well					
Fixed Costs, including interest (6%)		1,377	1,666	1,604	1,546
Operating Costs 1/		2,038	2,593	5,894	7,385
Interest on Distribution Lines $\frac{(2212 \times 6\%)}{2}$		66	66	66	66
Maintenance of Main Distribution		18	18	18	18
	Total	3,499	4,343	7,582	9,015
3. Total Investment, 10,000 ha. Project					
Project Cost		2,647,240	3,011,550	2,792,250	2,817,920
Pre-Investment Ground Survey		505,453	505,453	505,453	505,453
	Total	3,152,693	3,517,003	3,297,703	3,323,373
		$315/ha.	$353/ha.	$330/ha.	$332/ha.
4. Annual Cost, 10,000 ha. Project					
Annual Cost x 10,000/58.8		595,068	738,605	1,289,456	1,533,163
Test Program, Interest and Amortization (.08 x 505,453)		40,437	40,437	40,437	40,437
	Total	635,505	779,042	1,329,893	1,573,600
		$64/ha.	$78/ha.	$133/ha.	$157/ha.

1/ Operating Cost for 4,590 centimeter-hectares or .459 MCM of water pumped per season.

TABLE 45
Land Classification - San Miguel Basin HARZA

Class	Gross Area (Hectares)
Well Drained Lands	
1	5,600
2s	2,800
2t	6,200
2st	2,800
2sd	3,100
3t	2,500
3st	2,000
Sub-Total	25,000
Imperfectly Drained Lands*	
4d (2sd)	4,000
Lands Requiring Project Drainage and Flood Protection*	
5d (3sd)	10,000
5d (4sd)	5,000
5d (4Pstd)	2,600
5d (4R)	4,400
Sub-Total	26,000
Total	51,000

* Classes in Brackets indicate potential class with reclamation

TABLE 46 HARZA - SAN MIGUEL
Principal Crops (%)

Land Classes	Cotton	Corn or Millet	Rice	Sugar Cane Vegetables	Pasture	Non-Prod: Areas
1-2-3	80	15	2	1	2	-
4d (2sd)	50	20	2	-	28	-
5d (3sd)	5	5	5	-	85	-
5d (4sd)	10	20	5	-	65	-
5d (4 Pstd)	5	5	5	-	85	-
5d (4R)	-	-	-	-	-	100

TABLE 47 HARZA - SAN MIGUEL
Present Crop Yields (Kg/Hectare)

Crop	Land Classes	
	Classes 1, 2, 3	Classes 4, 5
Cotton	2,725	2,320
Corn	2,725	1,955
Rice	1,955	1,955
Sugar Cane	103,000	-
Pasture	33 (AUM)	30 (AUM)

TABLE 48 HARZA - SAN MIGUEL
Land Classification With and Without Reclamation
(hectares)

Land Classes	Without Reclamation	With Reclamation	Change
2sd		4,000	4,000
3sd	-	10,200	10,200
4d	4,300	-	- 4,300
4sd	-	5,000	5,000
4 Pstd	-	2,500	2,500
4R	-	4,300	4,300
5d	21,700	-	-21,700
Total	26,000	26,000	0

TABLE 49
HARZA - SAN MIGUEL

Projected Land Use with Drainage and Flood Control Only
(percentage of total)

	Imperfectly Drained Soils 4d (sd) Season		Poorly Drained Lands 5d (sd) Season		5d (4sd) Season	
	Wet	Dry	Wet	Dry	Wet	Dry
Cotton	75	-	40	-	20	-
Corn	20	10	30	20	30	20
Rice	2	-	15	-	25	-
Vegetables	1	-	-	-	-	-
Pasture	2	-	15	-	25	25
	100	10	100	20	100	45

TABLE 50
HARZA - SAN MIGUEL

Projected Land Use With Drainage, Flood Control, Irrigation
(percentage of total)

Crop	Land Classes 1 - 3		Land Classes 4 - 5	
	Wet Season	Dry Season	Wet Season	Dry Season
Cotton	65	-	40	-
Corn	25	50	34	45
Rice	2	2	15	15
Vegetables	5	5	1	5
Pasture	3	3	10	10
Total	100	60	100	75

TABLE 51 HARZA - SAN MIGUEL

ESTIMATED PRESENT CROPPED AREA AND CORRESPONDING PRODUCTION

Crop	Land Classes 1 - 3			Land Classes 4 - 5			Total Production	
	Area (h)	Yields (kgs)	Production (tons)	Area	Yields (kgs)	Production (tons)	Area (h)	Production (tons)
Cotton	17,725	2,725	48,300	2,725	2,320	6,322	20,450	54,622
Corn	3,320	2,725	9,047	2,140	1,955	4,184	5,460	13,231
Rice	440	1,955	860	855	1,955	1,671	1,295	2,531
Vegetables	-	-	-	-	-	-	-	-
Pasture	440	33	(14,520)	13,380	26	(347,880)	13,820	(362,400)
Sugar Cane	225	103,000	23,175	-	-	-	225	23,175
Non-Prod.	-	-	-	3,900	-	-	-	-
Total	27,150			23,000			45,150	

TABLE 52 HARZA - SAN MIGUEL

PROJECTED YIELDS AND PRODUCTION WITH DRAINAGE AND FLOOD CONTROL (Land Classes 4 and

Crop	Wet Season			Dry Season			Total Production		
	Area (h)	Yields (kgs.)	Production (tons.)	Area (h)	Yields (kgs.)	Produc. (tons.)	Present (tons.)	W/Drainage (tons)	Increase (tons)
Cotton	9,200	2,590	23,828	-	-	-	6,322	23,828	17,506
Corn	4,600	2,725	12,535	4,600	1,320	6,072	4,184	18,607	14,423
Rice	3,450	2,590	8,936	-	-	-	1,671	8,936	7,365
Vegetables	260	51,800	12,950	-	-	-	Neg.	12,950	12,950
Pasture	5,500	40	(220,000)	5,500	11	(60,500)	(347,880)	(280,500)	(-67,380)
Total	23,000	-	-	10,100	-	-	-	-	-

TABLE 53 HARZA - SAN MIGUEL

PROJECTED YIELDS AND PRODUCTION WITH DRAINAGE, FLOOD CONTROL AND IRRIGATION

Crop	Land Classes 1 - 3				Land Classes 4 - 5				Total	
	Wet Season		Dry Season		Wet Season		Dry Season			
	Area (h)	Yields (Kgs)	Area (h)	Yields (Kgs)	Area (h)	Yields (Kgs)	Area (h)	Yields (Kgs)	Area (h)	Total (tons)
Cotton	14,400	3,270	-	-	9,200	2,590	-	-	23,600	70,916
Corn	5,550	3,900	11,100	3,900	7,800	2,900	10,340	2,900	34,790	117,541
Rice	450	2,900	450	2,900	3,450	2,900	3,450	2,590	7,800	125,505
Vegetables	1,100	63,600	1,100	63,600	250	58,630	1,150	58,630	3,600	222,000
Pasture	650	43	650	43	2,300	26	2,300	26	5,900	(175,000)
Totals	22,150	-	13,300	-	23,000	-	17,240	-	75,690	-

TABLE 54

BENEFIT-COST COMPARISONS OF ALTERNATIVE PLANS 1/
(Flood Control & Drainage for 20,000 Hectares - Surface Irrigation for 16,000 Hectares)

Alternatives	Hydroelectric Generation Installed (Kw)	(Gwh/yr.)	Investment (US $ Millions)	Annual Cost (U.S. $1000)	Annual Benefits U.S. $1,000)	Benefit:Cost Ratios Stage	Total	Incremental Costs & Benefits for Power Compared to Recommended Plan: Investment (US $ Million)	Annual Costs (US $ 1000)	Benefits (US $1000)	B/C Ratios
1. RECOMMEND PLAN - (Storage at Lake Olomega)											
Flood Control & Drainage-(20,000 hectares) 2/			12.3	1085	1620	1.5					
Surface Irrigation (16,000 hectares)			4.8	437	1260	2.9					
TOTAL - AGRICULTURAL DEVELOPMENT			17.1	1522	2880		1.9				
Power Production (Potential Development with Olomega Storage)											
Pump Storage	50	134	17.9	1924	1668	0.85					
El Delirio 3/	16	55	3.6	373	527	1.41					
TOTAL - POWER POTENTIAL	66	189	21.5	2347	2195		0.9				
TOTAL AGRICULTURE & POWER	66	189	44.6	4839	6935		1.4	21.5	2347	2195	0.90
2. SAN ESTEBAN STORAGE 3/ - Rio Grande de San Miguel Water Only)											
Scheme a. - Low Dam (El.142)	No power		29.0	2387	2880		1.21				
Scheme b. - Low Dam (El.145.5)	5	25	32.8	2753	3081		1.12	15.7	1231	201	.16
Scheme c. - Medium Dam (El.153) without El Delirio	15	51	38.9	3287	3407		1.04	21.8	1765	527	0.30
Scheme d. - Medium Dam (El.153) with El Delirio	27	105	41.9	3612	3844		1.06	24.8	2090	964	0.46
3. SAN ESTEBAN STORAGE WITH RIO TOROLA DIVERSION 4/											
Scheme a. - High Dam (El.161) without El Delirio	35	115	53.2	4522	4087		0.90	36.1	3000	1207	0.40
Scheme b. - High Dam (El. 161) with El Delirio	55	216	57.4	4966	4884		0.98	40.3	3444	2004	0.58
4. SAN ESTEBAN STORAGE WITH OCEAN TUNNEL 4/											
Scheme a. - High Dam (El. 161)	35	115	53.2	4522	4087		0.90	36.1	3000	1207	0.40
Scheme b. - High Dam with Ocean Tunnel and Power Plant	70	288	87.5	7334	5470		0.75	70.4	5812	2590	0.45

1/ Groundwater irrigation for 10,000 not included since costs for this component is constant for all alternatives.
2/ Variation to this scheme, included flood controls and drainage without irrigation.
3/ Power at El Delirio without the pumped storage project discussed in narrative.
4/ Agricultural areas for development and agricultural benefits same as for the recommended plan (Alternative I).

TABLE 55
HARZA - SAN MIGUEL

SUMMARY OF INVESTMENT COSTS BY FUNCTION (1000's of US$)

Part A.	Flood Control and Drainage - 20,000 Hectares	
	Direct Costs	$ 8,675
	Contingency (15%)	1,301
	Sub-total	9,976
	Engineering, administration, overhead (12%)	1,200
	Total	11,176
	Interest during construction (10%)	1,120
	Total Investment	$ 12,296
	Total Investment per hectare	615
Part B.	Surface Irrigation - 16,000 Hectares	
	Direct Costs	$ 3,395
	Total Surcharges (42%)	1,390
	Total Investment	$ 4,785
	Total Investment per hectare	$ 299
Part A and Part B		$ 17,081
Part A and Part B per hectare		$ 914
Part C.	Pump - Well Irrigation - 10,000 Hectares	
	Wells and Distribution Systems	$ 4,000
	Additional Canals	265
	Total Direct Costs	$ 4,265
	Total Surcharge (42%)	1,835
	Total Investment	$ 6,100
	Total Investment per Hectare	$ 610
	Total Investment Part A, Part B and Part C	$ 23,181

TABLE 56
HARZA - SAN MIGUEL

Summary of Investment Costs by Project Areas (1,000's of US $)

Olomega

Part A.	Flood control and drainage 9,000 Hectares	
	Direct Costs	$ 4,580
	Contingencies (15%)	$ 688
	Sub-total	$ 5,268
	Engineering, administration, overhead (12%)	631
	Total	$ 5,899
	Interest during construction (10%)	590
	Total Investment	$ 6,489
	Total Investment per Hectare	$ 662

TABLE 56 (Cont.)

Part B. Surface Irrigation System - 9,000 Hectares	
Direct Costs	$ 1,962
Total Surcharge (42%)	825
Total Investment	$ 2,787
Total Investment per Hectare	310
Total Part A and B	$ 9,276
Total Part A and B per Hectare	$ 1,030
Jocotal	
Part A. Flood Control and Drainage - 5,000 Hectares	
Direct Costs	$ 3,494
Total Surcharge (42%)	1,450
Total Investment	$ 4,944
Total Investment per Hectare	$ 989
Part B. Surface Irrigation System - 5,000 Hectares	
Direct Costs	$ 1,032
Total Surcharge (42%)	448
Total Investment	$ 1,480
Total Investment per Hectare	296
Total Part A and B	$ 6,424
Total Part A and B per Hectare	$ 1,285
San Dionisio	
Part A. Flood Control and Drainage 2,000 Hectares	
Direct Costs	$ 330
Total Surcharge (42%)	139
Total Investment	469
Total Investment per Hectare	$ 234
Part B. Surface Irrigation - 2,000 Hectares	
Direct Costs	$ 365
Total Surcharge (42%)	153
Total Investment	$ 518
Total Investment per Hectare	$ 260
Total Part A and B	$ 987
Total Part A and B per Hectare	$ 494

TABLE 56 (Cont.)

Usulutan - Vado Marín
Pump - Well Irrigation - 10,000 Hectares

Direct Costs	$ 4,523
Total Surcharge (42%)	1,977
Total Investment	$ 6,500
Total Investment per Hectare	650

Resume

Olomega Total	$ 9,300
Olomega per Hectare	$ 1,030
Jocotal - San Dionisio Total	$ 7,400
Jocotal - San Dionisio per Hectare	950
Usulután - Vado Marín Total	6,500
Usulután - Vado Marín per Hectare	$ 650
Project Total	$ 23,200
Project Total per Hectare (average)	$ 895

TABLE 57
HARZA - SAN MIGUEL

Annual Costs

	Total	Per Hectare
Part A		
Flood Control and Drainage	Total	Per Hectare
20,000 Hectare	$ 1,085,000	$ 54
Surface Irrigation		
16,000 Hectares4	437,000	27
Groundwater Irrigation		
10,000 Hectares	970,000	97
	$ 2,492,000	
Part B		
Olomega Project		
9,000 Hectares	$ 900,000	$ 100
Jocotal - San Dionisio Project		
7,000 hectares	580,000	83
Usulutan - Vado Marín Project		
10,000 Hectares	1,012,000	101
Total	$ 2,492.000	

TABLE 58
HARZA - SAN MIGUEL

Increased Benefits from Flood Control, Drainage, Irrigation

	Present Income Without Improvements	With Flood Control and Drainage	With Flood Control, Drainage, and Irrigation
Area benefitted, Hectares	20,000	20,000	20,000
Gross Farm Income	₡ 6,535,100	₡20,909,000	₡ 32,361,900
Farm Expense	₡ 4,722,400	₡14,519,000	20,429,000
Net Farm Income	₡ 1,812,700	₡ 6,390,000	11,932,900
Per Hectare	₡ 91	₡ 320	₡ 597
Net Increased Income			
Per Hectare	-	₡ 229	₡ 506
Total ₡	-	₡ 4,580,000	₡ 10,120,000
Total $	-	$ 1,832,000	$ 4,048,000
Per Hectare	-	$ 92	$ 202

TABLE 59
HARZA - SAN MIGUEL
Increased Benefits From Irrigation

	Present Income Without Irrigation	Projected Income With Irrigation
Area Benefitted, Hectares	10,000	10,000
Gross Farm Income	₡ 14,960,800	₡ 22,413,000
Farm Expenses	₡ 10,119,100	12,316,000
Net Farm Income	₡ 4,841,700	₡ 10,097,000
Per Hectare	₡ 484	₡ 1,010
Net Increased Income		
Per Hectare	-	₡ 526
Total Area ₡	-	₡ 5,260,000
Total Area $	-	$ 2,104,000
Per Hectare	-	$ 210

TABLE 60
HARZA - SAN MIGUEL
Annual Equivalent Benefits

	ANNUAL BENEFITS ($) Gross	Discounted
A. Aspects of Development		
1. Flood Control and Drainage		
20,000 Hectares		
Per Hectare	91	81
Total	1,830,000	1,620,000
2. Surface Irrigation		
16,000 Hectares		
Per Hectare	111	99
Total	1,400,000	1,260,000
Sub-Total		
Per Hectare	202	180
Total	3,232,000	2,880,000
3. Groundwater Irrigation		
10,000 hectares		
Per Hectare	210	186
Total	2,100,000	1,860,000
4. Total Development		
26,000 Hectares		
Per Hectare	205	182
Total	5,332,000	4,740,000
B. Project Areas (Flood Control, Drainage, Irrigation)		
1. Olomega Project - 9000 Hectares		
Per Hectare	180	160
Total	1,622,000	1,440,000
2. Jocotal - San Dionisio Project		
7,000 Hectares		
Per Hectare	180	160
Total	1,260,000	1,120,000
3. Usulutan - Vado Marín Project		
10,000 Hectares		
Per Hectare	245	182
Total	2,450,000	1,820,000
Total Development	5,332,000	4,740,000

TABLE 61
HARZA - SAN MIGUEL
Benefit - Cost Ratios

	Annual Benefits	Annual Costs	Ratio
A. Aspect of Development			
Flood Control and Drainage			
20,000 Hectares	1,620	1,085	1.5
Surface Irrigation			
16,000 Hectares	1,260	437	2.9
Sub-Total	2,880	1,522	1.9
Groundwater Irrigation			
10,000 Hectares	1,860	970	1.9
Total Development	4,740	2,492	1.9
B. Project Areas			
Olomega Project - 9,000 Hectares	1,440	90	1.6
Jocotal - San Dionisio Project - 7,000 Has.	1,120	580	1.9
Usulutan-Vado Marín Project-			
10,000 Hectares	2,180	1,012	2.2
Total Development	4,740	2,492	1.9

The Benefit-Cost Ratio is figured on direct benefits alone. Any inclusion of indirect benefits would favorably affect the ratio.

TABLE 62

HARZA - SAN MIGUEL

AGRICULTURAL INCOME WITH AND WITHOUT FLOOD CONTROL, DRAINAGE AND IRRIGATION

CROPS	Area (%)	Area (Hectare)	Crop Yields (Kgs.)	Total Production (Tons)	Unit Price (¢)	Gross Value ¢1000	Production Costs Per Hectare ¢	Production Costs Total ¢1000	Net Returns ¢1000
Present Agricultural Income Without Flood Control and Drainage									
Cotton	12	2,400	2,320	5,568	625	3,480	1,150	2,760	720
Corn	9	1,800	1,955	3,519	240	844.6	400	730	125
Rice	4	800	1,955	1,564	375	586.5	538	430	156
Pasture	58	11,600	28	324,800	5	1,624.0	70	812	812
Others	17	3,400	-	-	-	-	-	-	-
Total	100	20,000	-	-	-	6,535.1	-	4,732	1,812
Per Hectare						¢ 327	-	¢ 236	¢ 91
Projected Agricultural Income With Flood Control and Drainage									
Cotton	40	8,000	2,590	20,720	625	12,950	1,150	9,200	3,750
Corn	40	8,000	2,025	16,200	240	3,888	400	3,200	688
Rice	15	3,000	2,590	7,770	375	2,914	538	1,614	1,300
Vegetables	1	200	58,630	11,726	25	2,932	845	169	124
Pasture	24	4,800	36	172,800	5	864	70	336	528
Total	120	24,000	-	-	-	20,909	-	14,519	6,390
Per Hectare						1,045		¢ 725	¢ 320
Projected Agricultural Income With Flood Control Drainage and Irrigation									
Cotton	40	8,000	2,590	20,720	625	12,950	1,150	9,200	3,750
Corn	79	15,800	2,900	45,820	240	10,997	425	6,715	4,282
Rice	30	6,000	2,745	16,470	375	6,176	550	3,300	2,876
Vegetables	6	1,200	58,630	70,356	25	1,759	845	1,014	745
Pasture	10	2,000	48	96,000	5	480	100	200	280
Total	165	33,000	-	-	-	32,362	-	20,429	11,933
Per Hectare						¢1,618		¢1,021	¢ 597

TABLE 63
HARZA - UPPER LEMPA

Distribution of Arable Land, Upper Río Lempa Basin

Department	Hectares	%
Chalatenango	23,200	62
Cuscatlan	5,500	15
San Salvador	6,500	18
La Libertad	1,800	5
	37,000	100

TABLE 64
HARZA - UPPER LEMPA

Land Capability

Classification Group	Hectares	%
I	6,500	28
II	11,400	50
III	5,300	22
Sub-Total	23,200	100
IV	13,800	
Total	37,000	

TABLE 65
HARZA - UPPER LEMPA

Potentially Irrigable Land

Probable Water Supply	Area (H) by Land Capability I	II	III	Total
Direct stream diversion	-	3,100	3,000	6,100
Pumping from stream or canals	400	-	-	400
Ground water pumping	6,100	8,300	2,300	16,700
	6,500	11,400	5,300	23,200

TABLE 66
HARZA - UPPER LEMPA

Estimated Value of Crop Production

	Area Cropped (has.)	Yields		Total Production (tons)	Unit Price	Gross Value (₡1,000)
		Unit	Amount			
Part A - Present Crop Production						
Corn	4,600	Kgs/ha.	900	4,140	210	869
Sorghum	1,400	Kgs/ha.	900	1,260	200	252
Beans	900	Kgs/ha.	500	450	420	189
Rice	2,000	Kgs/ha.	1,100	2,200	320	704
Cotton	600	Kgs/ha.	1,400	840	600	504
Sugar Cane	3,000	Tons	60	180,000	17	3,060
Improved Pastures	3,500	AUM	20	70,000	5	350
Native Pastures	7,000	AUM	2	14,000	5	70
Total	23,000					5,998
Total per Hectare						₡ 261
Part B - Projected Crop Production - With Drainage						
Corn	6,000	Kgs/ha.	2,000	12,000	210	2,520
Sorghum	1,800	Kgs/ha.	2,000	3,600	200	720
Beans	1,200	Kgs/ha.	1,000	1,200	420	504
Rice	3,000	Kgs/ha.	2,000	6,000	320	1,920
Cotton	1,500	Kgs/ha.	2,200	3,300	600	1,980
Sugar Cane	4,500	Tons	100	450,000	17	7,650
Improved Pastures	4,500	AUM	30	135,000	5	675
Native Pastures	500	AUM	20	10,000	5	50
Total	23,000					16,019
Total per Hectare						₡ 696
Part C - Projected Crop Production - With Drainage and Irrigation						
Corn	11,000	Kgs/ha.	2,800	30,800	210	6,468
Sorghum	3,400	Kgs/ha.	2,800	9,520	200	1,904
Beans	2,200	Kgs/ha.	1,500	3,300	420	1,386
Rice	5,400	Kgs/ha.	2,000	10,800	320	3,456
Cotton	2,000	Kgs/ha.	2,200	4,400	600	2,640
Sugar Cane	5,000	Tons	115	575,000	17	9,775
Improved Pastures	4,500	AUM	50	225,000	5	1,125
Native Pastures	500	AUM	4	2,000	5	10
Total	37,000					26,764
Total per Hectare						₡ 723

TABLE 67
HARZA - UPPER LEMPA

Present And Projected Yields (Per Hectare)[1/]

Crop	Unit	Present Yields	Projected Yields		
			With Drainage	With Drainage and Irrigation	Potentials Yields
Corn and Sorghum	Kgs.	900	2,000	2,800	3,200
Beans	"	500	1,000	1,500	1,800
Rice	"	1,100	2,000	2,000	2,600
Cotton	"	1,400	2,200	2,200	2,800
Sugar Cane	Tons	60	100	115	120
Improved Pasture	AUM[2/]	20	30	50	60
Native Pasture	AUM	2	4	4	4

1/ Assumes moderate increases as a result of improved cultural practices.
2/ Animal-Unit Months

TABLE 68
HARZA - UPPER LEMPA

Estimated Increase in Annual Crop Income

Item	Present Income	Projected Income	
		With Drainage	With Drainage & Irrig.
	₡	₡	₡
Gross Farm Income (₡)	6,000,000	16,000,000	27,000,000
Farm Expenses (₡)	3,600,000	9,600,000	16,200,000
Net Income (₡)	2,400,000	6,400,000	10,800,000
Total Increase Net Income	-	4,000,000	8,400,000
Average per Hectare (₡)	113	175	365
Equivalent US$	45	70	145

TABLE 69
HARZA - UPPER LEMPA

Estimated Investment Costs (Per Hectare)

Drainage		
Land Capability Group I	₡	650
Land Capability Group II		1,150
Land Capability Group III		560
Weighted Average and rounded to nearest 100	₡	900
Irrigation	US$	360
Well System alone	₡	650
Laterals and land preparation		200
40% for contingencies, engineering, interest, etc.		340
Total rounded to nearest 100	₡	1,200
	US$	480

TABLE 70
HARZA - UPPER LEMPA

Estimated Annual Costs (Per Hectare)

	Amortization	Operation & Maintenance	Total
Drainage Works			
Land Capability Group I	43	22	65
Land Capability Group II	73	22	95
Land Capability Group III	38	22	60
Weighted average			80
Irrigation Works			
Pum-well, distribution system	70	50	₡ 120

TABLE 71
HARZA - UPPER LEMPA

Benefit/Cost Ratio

Development Potential	Annual Benefits ₡	Annual Costs ₡	B/C Ratio
Drainage	155	80	1.9
Irrigation	165	120	1.4
Total	320	200	1.6

TABLE 72
GARCIA PRIETO - LA CABAÑA

CANE PRODUCTION AS REPORTED BY HACIENDA LA CABAÑA

Harvest Year	Cut Tons Per manzana	Manzanas Cut	Estimated Life before replanting
59/60	48.0	744	Up to 5 years
60/61	45.0	723	Up to 4 years
61/62	56.7	772	Up to 4 years
62/63	58.5	711	Up to 3 years
63/64	45.5	919.5	Up to 4 years
64/65	45.0	1,136	Up to 5 years

TABLE 73
GARCIA PRIETO - LA CABAÑA

ESTIMATED COSTS OF GROUND WATER PUMPING

Well drilling	₡ 257,000
Pumping equipment	366,000
4000 KVA transmission line w/transformers	32,000
Secondary transmission line (40 km.)	80,000
	₡ 735,000

TABLE 74
GARCIA PRIETO - LA CABAÑA

ECONOMIC STUDY FOR LA CABAÑA PROJECT

Well drilling, 2,610 meters at ¢100/m	¢	261,000
Pumps for wells		312,000
Pumps for river diversion		18,000
Intake structure for river pumping		31,200
High tension lines		36,800
Low tension lines		64,800
Irrigation canals, 45 km. at ¢250/km		11,250
Lateral drains and roads, ¢1,485/km		66,775
Drainage canals		81,700
Channel improvements		35,000
Drainage outlet structures		44,000
Levees, ¢125/hectares		160,000
Sub-total	¢	1,122,525
Engineering, administration, contingencies (20%)		224,505
Total investment to irrigate 1,280 hectares	¢	1,347,020
Annual Charges		
Fixed Charges		
Interest and amortization of ¢1,347,020 at 6% for 20 yr.	¢	117,200
Depreciation of pumpts, 5% for 15 years		15,275
Depreciation of wells, intake structures, power lines, 5% for 25 years		8,240
	¢	140,715
Maintenance Charges		
Irrigation canals		5,625
Lateral drains		33,400
Drainage Canals		2,000
Pumps and transmission lines		975
	¢	42,000
Operationa		
Pumping	¢	63,900
Hand labor for irrigation of 1,280 hectares 10,000 man days at ¢3.00		30,000
	¢	93,900
Total of Annual Charges	¢	276,565
Annual Charge per hectare	¢	218
Annual charge per manzana	¢	151

Note: It was estimated that an increase of 10 tons of sugar cane per manzana is sufficient to pay all irrigation costs.

efforts are needed to make sure that it can serve the needs of various groups of credit users effectively. Thereafter, major efforts to develop sufficient sources of financing must follow. One element in such financing would be that contemplated under Project 10.3 Financing Livestock Development which belongs in this priority group, subject to further development and to support through immediate action on Project 10.1.1 Short Course in Ranch Management and Project 10.2.1 Developing Modern Sales-Yards at Livestock Assembly Points.

e) Project 5.1.1. The Third Census of Agriculture. This project is so basic to future planning for agricultural development that it deserves further large preparatory inputs before being initiated about 1972.

f) Project 8.1 Production and Distribution of Improved Planting Stock for Selected Fruits. The preliminary description of this project makes a good case for developing new sources of improved planting stock for selected fruits, but alternative means of achieving this objective need to be examined before the project is implemented in its present form.

g) Project 9.4. Soil Conservation in the Basin of the Río Grande of San Miguel. Implementation of this project is a necessity before construction proceeds on Project 2.6 Development of the Olomega Area, and the seriousness of the soil erosion problem on the slopes of the San Miguel volcano make this project of urgent importance, quite apart from the Olomega development.

III. Other Projects of Importance.

a) Project 2.10 Irrigation in the Upper Lempa Valley and Project 2.11 Irrigation in the Jiboa Area. Planning needs to proceed on these projects with a view toward their implementation starting in 1984.

b) Project 3.12. Community Storage Construction Sponsored by the Federación de Cajas de Crédito.

This project is so near completion that it is not included among the major investment projects of the two previous groups.

c) Project 5.2.1. Agrarian Reform in the Coastal Zone. This is another project which has been in the process of implementation for some time. The urgency of further efforts under this project will depend upon how it relates to new policies for agrarian reform now in the development stage.

d) Project 5.3.1. Developing Cooperative Organization. In its present form, this is not a major investment-type project, although it is highly significant in relation to the overall agricultural development effort. Progress in developing the structures and activities of the new Institute should be encouraged and assisted.

e) Project 7.1. Agricultural Diversification. This project is well underway and is producing useful results. Inputs should be continued.

f) Project 9.1. Rice Production. Further planning efforts offer the prospect of developing a significant loan proposal.

g) Project 9.2. Protecting Cotton from Insects and Diseases. This project is already well underway and is producing useful results.

(Technical Appendix)

APPENDIX TO CHAPTER II

AGRICULTURE IN THE SALVADORAN ECONOMY, 1970-90: AN OVERVIEW

A PLANNING MODEL FOR EL SALVADOR'S AGRICULTURAL SECTOR, 1970-90

This Appendix presents in concise form the structure of the macroeconomic model on which the discussion in Chapter II is based. The first section lists the variables contained in the model, together with their "names."1/

I. Dictionary

(a) All monetary variables are at 1967 prices and unless otherwise noted are in millions of Salvadoran colones.

(b) "(P)" denotes a predetermined variable. All other variables are endogenous, i.e., determined by the model.

(c) Because of the rules of the FORTRAN computing language, no "legal" name for a general variable can have more than 6 letters nor can it begin with any of the letters I through N; this explains some of the odd names used.

(d) "Agricultural sector" (abbreviated to "ag") means agriculture livestock, fishing and forestry; "nonagricultural sector" (abbreviated to "nonag") comprises all other sectors of the economy.

1/ GDP (Gross Domestic Product) and PTB (Producto Territorial Bruto) are used interchangeably in this appendix.

Variable Name	Definition
AGPROD:	Agricultural output per man, in colones; defined by equation (53).
CAPBEG:	Capital stock of nonag, beginning of year.
CAPEND:	Capital stock of nonag, end of year.
CAPRAT:	Capital stock of nonag, per man employed, in colones; defined by equation (3).
CONCAP:	Private consumption expenditures per capita, in colones; defined by equation (19).
CONFOD:	Private consumption expenditures on food.
CONFDR:	Private consumption expenditures on food, per capita, in colones; defined by equation (20).
CONGAG:	Current government expenditures on ag (e.g. administration, research, extension, education).
CONGNG:	Current government expenditures less CONGAG (q.v.) and less subsidies.
CONGRA:	Ratio of current government expenditures to GDP at factor cost, percent; defined by equation (23a).
CONPNF:	Private consumption expenditures on nonfood commodities, plus services.
CONSG:	Current government expenditures.
CONSP:	Private consumption expenditures.
D:	Depreciation on capital stock of whole economy
(P)DAG:	Depreciation on recorded capital stock of ag.
DNAG:	Depreciation on capital stock of nonag.
DOSARA:	Domestic gross savings ratio, as fraction of GDP at factor cost, percent; defined by equation (48).

Variable Name	Definition
(P) EL:	Labor force, midyear, in thousands of persons.
ELRES:	Labor force available for ag, midyear, in thousands of persons; defined by equation (52).
EM:	Imports of goods and nonfactor services.
EMCAP:	Imports of capital equipment and construction materials.
EMCONO:	Imports of consumption goods other than food products.
(P)EMFACS:	Net imports of factor services.
(P)EMFOOD:	Imports of food products not produced in El Salvador (e.g. wheat).
EMGOOD:	Imports of merchandise only.
EMIAG:	Imports of raw and semi-finished materials for ag.
EMINAG:	Imports of raw and semi-finished materials for nonag.
EMSERV:	Imports of nonfactor services.
(P)ENAG:	Employment in nonag, midyear, thousands of persons.
FEINSE:	Purchases of materials for current production by ag from nonag and from abroad; e.g. Fertilizers, Insecticides, Seeds, Gasoline.
FEXT:	Net inflow of foreign resources required to balance external account.
FINT:	Net inflow of foreign resources required to balance internal account.
(P)FLOPAG:	Assumed "floor" to agricultural output per man, in colones.

Variable Name	Definition
FORIN:	Planned net inflow of foreign resources; defined by equation (50).
FOSARA:	Foreign saving ratio, as fraction of GDP at factor cost, percent; defined by equation (51).
G:	Gross recorded domestic fixed capital formation in whole economy.
GAG:	Gross recorded domestic fixed capital formation in ag.
GG:	Current government revenues available for public investment; defined by equation (32).
GGRAT:	Variable GG (q.v.) as fraction of GDP at factor cost, percent; defined by equation (33).
GNAG:	Gross recorded domestic fixed capital formation in nonag.
P:	Gross domestic product at market prices.
(P)PAG:	Gross domestic product at market prices, originating in ag.
PDOMFD:	Gross domestic product at market prices originating in sector producing food for domestic consumption.
PNAG:	Gross domestic product at market prices, originating in nonag.
PNAGFC:	Gross domestic product at factor cost, originating in nonag.
(P)POP:	Total population, midyear, in thousands of persons.
PRODNG:	Product per man employed in nonag, colones; defined by equation (2).
PXAGTR:	Gross domestic product at market prices originating in traditional agricultural export sector (coffee, cotton, sugar).

Variable Name	Definition
SAVDOM:	Domestic saving, net of depreciation allowances.
STOCKS:	Increase of inventories in the whole economy (negative if decrease).
SUB:	Government subsidies to the private sector.
SUREAG:	Surplus labor force in ag, in thousands of persons; defined by equation (54).
TAX:	Current tax and nontax revenues of central government.
TAXEX:	Export taxes.
TAXRAT:	Ratio of tax (q.v.) to GDP at factor cost, percent; defined by equation (31).
TDIR:	Direct taxes, and nontax revenues, of central government (does not include export taxes).
(P)TIME:	Time in years, measured from 1955=1, 1956=2, etc.
TIND:	Indirect taxes paid to central government (includes import taxes).
V:	National income at market prices (i.e., net national product at market prices).
X:	Exports of goods and nonfactor services.
XAG:	Exports of goods from ag.
XAGNTR:	Nontraditional agricultrual exports; defined by equation (40).
(P)XAGTR:	Traditional agricultural exports (coffee, cotton, sugar).
(P)XNAG:	Exports of goods from nonag, and all nonfactor services.
(P)Y:	Gross domestic product at factor cost.

Variable Name	Definition
YDISP:	Disposable income; defined by equation (15).
Z:	Gross national product at market prices.

There are 67 variables in the model, of which 12 (DAG, EL, EMFACS, EMFOOD, ENAG, FLOPAG, PAG, POP, TIME, XAGTR, XNAG, Y) are predetermined, and the other 55 are endogenous.

II. Equations

These are given in the order suitable for computation. The designation "(I)" in the margin denotes an identity, rather than an estimated equation. Such expressions as "PNAGFC(T)" refer to the variable (PNAGFC) at time T (e.g., 1970).

(I)	1.	PNAGFC(T)	=	Y(T) - PAG(T)
(I)	2.	PRODNG(T)	=	PNAGFC(T)/ENAG(T)
(I)	3.	CAPRAT(T)	=	CAPBEG(T)/ENAG(T)
	4.	CAPBEG(T)	=	$(a_4 + b_4$ TIME(T)) PNAGFC(T)
(I)	5.	CAPEND(T)	=	CAPBEG(T + 1)
	6.	DNAG(T)	=	b_6 CAPBEG(T)
(I)	7.	GNAG(T)	=	CAPEND(T) - CAPBEG(T) + DNAG(T)
	8.	GAG(T)	=	b_8 (PAG(T) - PAG(T-1)) + DAG(T)
	9.	CONGAG(T)	=	$(a_9 + b_9$ TIME(T)) PAG(T) + c_9
	10.	FEINSE(T)	=	b_{10}(PAG(T) - PAG(T-1)) + FEINSE(T-1)
(I)	11.	G(T)	=	GAG(T) + GNAG(T)
(I)	12.	D(T)	=	DAG(T) + DNAG(T)
	13.	TDIR(T)	=	$a_{13} + b_{13}$ PNAGFC(T) + c_{13} PAG(T)

	14.	TAXEX(T)	=	$a_{14} + b_{14}$ XAGTR(T-1)
(I)	15.	YDISP(T)	=	PNAGFC(T) + PAG(T) - EMFACS(T) - D(T) - TDIR(T) - TAXEX(T)
	16.	CONPNF(T)	=	$a_{16} + b_{16}$ YDISP(T)
	17.	CONFOD(T)	=	$a_{17} + b_{17}$ YDISP(T)
(I)				
(I)	18.	CONSP(T)	=	CONPNF(T) + CONFOD(T)
(I)	19.	CONCAP(T)	=	(CONSP(T)/POP(T)) x 100
(I)	20.	CONFDR(T)	=	(CONFOD(T)/POP(T)) x 100
	21.	CONGNG(T)	=	G_{21}(Y(T) - Y(T-1)) + CONGNG(T-1)
	22.	SUB(T)	=	$a_{22} + b_{22}$Y(T)
(I)	23.	CONSG(T)	=	CONGAG(T) + CONGNG(T) + SUB(T)
(I)	23a.	CONGRA(T)	=	(CONSG(T)/Y(T)) x 100
	24.	EMCAP(T)	=	$a_{24} + b_{24}$ G(T)
	25.	EMINAG(T)	=	b_{25}(PNAGFC(T) - PNAGFC(T-1)) + c_{25}(XNAG(T)) - XNAG(T-1)) + EMINAG(T-1)
	26.	EMIAG(T)	=	$a_{26} + b_{26}$ (PAG(T) + c_{26} FEINSE(T)
	27.	EMCONO(T)	=	$a_{27} + b_{27}$ CONPNF(T)
(I)	28.	EMGOOD(T)	=	EMCAP(T) + EMINAG(T) + EMIAG(T) + EMCONO(T) + EMFOOD(T)
	29.	TIND(T)	=	$a_{29} + b_{29}$ EMGOOD(T)
(I)	30.	TAX(T)	=	TDIR(T) + TAXES(T) + TIND(T)
(I)	31.	TAXRAT(T)	=	(TAX(T)/Y(T)) x 100
(I)	32.	GG(T)	=	TAX(T) - CONSG(T)
(I)	33.	GGRAT(T)	=	TAXRAT(T) - CONGRA(T)
(I)	34.	PNAG(T)	=	PNAGFC(T) + TIND(T) - SUB(T)

(I) 35. P(T) = PAG(T) + PNAG(T)

(I) 36. Z(T) = P(T) - EMFACS(T)

(I) 37. V(T) = Z(T) - D(T)

38. PXAGTR(T) = $a_{38} + b_{38}$ XAGTR(T)

39. PDOMFD(T) = b_{39} CONFOD(T) - EMFOOD(T)

(I) 40. XAGNTR(T) = PAG(T) - PDOMFD(T) - PXAGTR(T)

(I) 41. XAG(T) = XAGTR(T) + XNAGTR(T)

42. EMSERV(T) = $a_{42} + b_{42}$ Y(T)

(I) 43. EM(T) = EMGOOD(T) + EMSERV(T)

(I) 44. X(T) = XAG(T) + XNAG(T)

(I) 45. FEXT(T) = EM(T) + EMFACS(T) - X(T)

46. STOCKS(T) = b_{46}(Y(T) = Y(T-1))

(I) 47. SAVDOM(T) = V(T) - CONSP(T) - CONSG(T)

(I) 48. DOSARA(T) = ((SAVDOM(T) + D(T))/Y(T)) x 100

(I) 49. FINT(T) = G(T) + STOCKS(T) - D(T) - SAVDOM(T)

(I) 50. FORIN(T) = max (FEXT(T), FINT(T))

(I) 51. FOSARA(T) = (FORIN(T)/Y(T)) x 100

(I) 52. ELRES(T) = EL(T) - ENAG(T)

(I) 53. AGPROD(T) = (PAG(T)/ELRES(T)) x 1000

(I) 54. SUREAG(T) = ELRES(T) - ((PAG(T)/ FLOPAG(T)) x 1000)

There are 55 equations (including 23a), of which 35 are identities. There are 37 coefficients (parameters) which must be estimated as follows: A4, B4, B6, B8, A9, B9, C9, B10, A13, B13, C13, A14, B14, A16, B16, A17, B17, B21, A22, B22, A24, B24, B25, C25, A26, B26, C26, A27, B27, A29, B29, A38, B38, B39, A42, B42, B46.

III. Estimation of the Parameters of the Model

The levels of the 55 endogenous variables depend obviously on the assumed levels of the 12 predetermined variables, and on the values assumed for the 37 parameters. While it cannot be presumed that the parameter values relevant for the future are exactly those that have prevailed in the past, nevertheless the estimated past values can often serve as possible guides to the future. This is not always the case; sometimes the available data are insufficient for estimating past values, and sometimes one has strong grounds for believing that the relevant structure has changed, so that other approaches must then be tried; even if data are available they may not be extensive enough to permit the utilization of standard regression techniques. Generally speaking, however, the application of regression analysis to time series of past data provides valuable structural information.

We now proceed to describe briefly how each of the 20 non-identity equations has been estimated. First, two general remarks are in order:

(i) No attempt is made here to describe in detail how the various data series needed to make the estimates were obtained. These series were 29 in number, as follows: EMCAP, EMCONO, EMFOOD, EMIAG, EMINAG, EMSERV, EMFACS, TDIR, TAXES, TIND, CONFOD, CONPNF, CONGAG, CONGNG, SUB, PAG, PNAGFC, PXAGTR, PDOMFD, DAG, DNAG, GAG, G, CAPBEG, XAGTR, XNAG, STOCKS, FEINSE, TIME. Most of these were readily available, in either constant or current prices from the Revista Mensual of the Banco Central de Reserva, and in current prices were deflated either by an appropriate price series or by the GDP implicit price deflater. The functional classification of imports was based on that described in Annex I of a 1967 memorandum of RRNA on the balance of payments of El Salvador, while the breakdown between consumption of food and non-food items was obtained from the research staff of the Banco Central. Complete details of how any of these series were obtained are available upon request.

(ii) The (non-identity) equations contained in the model were obtained only with considerable

experimentation with other functional forms and combinations of variables. Thus in order to arrive at the dozen or so equations which were estimated by regression techniques, some 120 alternatives were tried, which involved in several cases variables that are not now in the model. No history of this experimentation is included here, but a brief account is available upon request.

Equation 4: $CAPBEG(T) = (a_4 + b_4\ TIME(T))\ PNAGFC(T)$

$a_4 = 1.92$, $b_4 = 0.03$, for 1968-80.

This equation is important, and presented the most trouble. What is needed is a production function for nonag, relating the output (value added) of these sectors to the inputs (capital, labor) which they use. Although very many alternative production functions were tried, none gave sensible results, due mainly to the presence of marked multi-collinearity between the explanatory variables, capital and labor. Accordingly, we fell back on the use of a simple capital/output ratio as a simple form of nonag production function (which implies that labor is not a limiting factor of production). This ratio has fallen rather steadily in the last decade from 3.0 - 3.2 in 1958-60, to 2.3 - 2.4 in 1965-67. It was believed that this fall represented the operation of two factors, the spreading of pre-existing overhead capital over a larger volume of output, and the effect of more narrowly defined increasing returns to scale, and so was not likely to be continued into the future. The equation above implies a ratio of 2.31 for 1967 (since T(1967) = 13) and thereafter a rise of 0.03 percentage points a year (a slight reversal of the previous period) until in 1980 it reaches a level of 2.7. Thereafter we have assumed that the nonag capital output ratio stays constant at 2.7, so equation 4 then becomes:

$CAPBEG(T) = 2.7\ PNAGFC(T)$ for 1981-1990

Equation 6: $DNAG(T) = b_6\ CAPBEG(T)$. ($b_6 = 0.0331$)

This value of b_6 was arrived at as follows: A CONAPLAN memorandum [6] of March 1964 gives estimates

of the reproducible capital stock for 1962. From p.2 there can be derived an estimate of end-of-year 1962 capital stock in nonag of 2,856.7 million colones. From some work of Dr. Clark Joel of RRNA, we estimate depreciation on capital in nonag for 1962 at 92.4 million colones. Gross investment in nonag in 1962 was ¢157.6 million. If d is the depreciation rate we may then proceed as follows, from the identity:

Capital stock at end of 1962 = Capital stock at beginning of 1962
- (Depreciation rate x Capital stock at beginning of 1962)
+ Gross investment during 1962

or 2856.7 = CAPBEG(1962) - 92.4 + 157.6
so CAPBEG(1962) = 2791.5
But d x CAPBEG(1962) = 92.4
so d = 92.4/2791.5 = 0.0331.

Equation 8: $GAG(T) = b_8 (PAG(T) - PAG(T-1)) + DAG(T)$.
($b_8 = 0.90541$)

From an RRNA memorandum by Dr. Richard Wheeler, Production Potential of El Salvador's Agricultural Sector, 1970-90, it is possible to estimate that for an increase in agricultural output of ¢370 million mentioned there, there would need to be an amount of ¢335 million of net fixed investment in ag. The ratio 335/375 equals 0.90541. This same ratio is assumed to hold for 1980-1990, given the maintenance of research, education and extension expenditures at appropriately high levels.

Equation 9: $CONGAG(T) = (a_9 + b_9 TIME(T)) PAG(T) + c_9$
$a_9 = -0.0095$, $b_9 = 0.00175$, $c_9 = 0$ for 1968-1979
$a_9 = 0.01175$, $b_9 = 0$, $c_9 = 25$ for 1980-1990

This equation does not reflect past experience (except for the base year) but instead corresponds to a deliberate shift in policy that would substantially raise the proportion of agricultural inputs devoted to government research, extension and education. In 1967, CONGAG was at a level of about 1.325 percent of PAG, and of this 0.625 percent represented administration (assumed here to rise proportionately with PAG), while the balance of 0.7 percent can be attributed to research, extension and education. The latter is assumed to rise more than proportionately to PAG until by 1980 total CONGAG has risen from 1.325 percent of PAG to 3.6 percent of PAG. Thus

$$\begin{aligned} CONGAG(T) &= 0.00625\ (PAG(T) + (0.007 + 0.00175\ (TIME(T)-13))\ PAG(T) \\ &= (0.00625 + (0.007 \times -13))\ PAG(T) + 0.00175\ TIME(T)\ PAG(T) \\ &+ (-0.00950 + 0.00175\ (TIME(T))PAG(T) \quad \text{for } T=\overline{14,25} \end{aligned}$$

From 1980 onward, it is assumed that expenditures on research, extension, and educational development will level off at ¢25 million, while the balance of current expenditure on agriculture by government is assumed to rise proportionately with PAG, with a coefficient of 0.1175; thus

$$CONGAG(T) = 0.1175\ PAG(T) + 25 \qquad \text{for } T = \overline{26,36}$$

Equation 10. $FEINSE(T) = b_{10}(PAG(T) - PAG(T-1)) + FEINSE(T-1)(b_{10} = 0.22162$

From the Wheeler memorandum already cited (see Equation 8), it appears that in the decade 1970-1980 an increase in annual inputs of fertilizers, insecticides, seeds and gasoline of ¢82 million will be needed for an increase in ag output levels by ¢370 million. The ratio 82/370 gives 0.22162. Note that all livestock feed is assumed to be purchased from within agriculture; this is not true, but neither is it true (as we are assuming) that all seeds are imported from outside the ag sector. The two errors should be offsetting to a considerable extent, however.

It is convenient to treat several of the next equations together, since they were all estimated on the basis of regression analysis of time series of past data, generally for the 10 years 1958-67. In each equation we give only the actually estimated coefficients; in parentheses underneath is recorded the t statistic (for significance, t should be about $\pm$ 2 or more), while attached to each equation is the multiple correlation coefficient (R^2) corrected for degrees of freedom, and the Durbin-Watson statistic (D/W). The latter tests for serial correlation in the residuals, a value of roughly 1.3 or more indicating lack of serious positive serial correlation. There are 11 equations in this group.

Equation 13:

$$\begin{array}{l} TDIR(T) = -20.89626 + 0.01851\ PNAGFC(T) + 0.08632\ PAG(T) \\ \qquad\qquad\quad (-4.4998)\quad (6.3356)\qquad\qquad\quad (6.6363) \\ \qquad\qquad R^2 = 0.9855,\quad D/W = 3.1605 \end{array}$$

Equation 14:

$$\begin{array}{l} TAXEX(T) = 7.74623 + 0.12935\ XAGTR(T-1) \\ \qquad\qquad\quad (-1.2069)\ (5.7200) \\ \qquad\qquad R^2 = 0.8035,\quad D/W = 2.2099 \end{array}$$

Equation 16:

$$\begin{array}{l} CONPNF(T) = -36.80179 = 0.58942\ YDISP(T) \\ \qquad\qquad\quad (-1.1833)\quad (27.4487) \\ \qquad\qquad R^2 = 0.9895,\quad D/W = 2.0864 \end{array}$$

Equation 17:

$$\begin{array}{l} CONFOD(T) = 180.5459 + 0.23940\ YDISP(T) \\ \qquad\qquad\quad (5.1466)\quad (9.8842) \\ \qquad\qquad R^2 = 0.9243,\quad D/W = 1.4279 \end{array}$$

Note that the marginal propensity to consume out of disposable income = $(G_{16} + G_{17})$ = (0.58942 + 0.23940) = 0.82882, so that the marginal propensity to save out of disposable income is (1-0.82882) = 0.17118.

Equation 22:

SUB(T) = -5.52303 + 0.01065 Y(T)
(-8.1087) (25.7313)
R^2 = 0.9881, D/W = 2.2703

Equation 24:

EMCAP(T) = -17.63138 + 0.48638 G(T)
(-3.1563) (20.0696)
R^2 = 0.9805, D/W = 1.6202

(for equation 25 see below)

Equation 26:

EMIAG(T) = -4.28863 + 0.01858 PAG(T) + 0.66228 FEINSE(T)
(-0.5959) (1.1213) (9.2518)
R^2 = 0.9705, D/W = 1.3370

Equation 27:

EMCONO(T) = -27.79268 + 0.21192 CONPNF(T)
(-2.0563) (12.8221)
R^2 = 0.9536, D/W = 1.9783

Equation 29:

TIND(T) = 53.92574 + 0.16946 EMGOOD(T)
(8.5240) (10.7787)
R^2 = 0.9356, D/W = 1.9682

Equation 38:

PXAGTR(T) = -10.05374 + 0.97711 XAGTR(T)
(-0.3482) (8.8661)
R^2 = 0.9182, D/W = 2.0404

Equation 42:

EMSERV(T) = -14.02980 + 0.045457 Y(T)
(-1.7327) (9.2378)
R^2 = 0.9143, D/W = 2.0470

This completes the group of equations which were estimated completely by regression techniques. As already indicated, the versions given above represent the "final" equations, arrived at after considerable experimentation.

However, in the case of the three tax equations, #13, #14, and #29, some "policy" adjustments had to be made to the coefficients. For if the estimated coefficients are used throughout the 21-year projection period, it turns out that the resulting tax revenues fall as a percentage of PTB, to such an extent that by 1980 the annual surplus of current revenues over current expenditures is insufficient to provide a reasonable proportion of the financing for government's capital expenditures; indeed, in several simulations the surplus is negative by the end of the period.

This poor performance arises mainly because the tax structure is such that too high a proportion of revenue comes from sectors of the economy which are growing relatively slowly; hence revenue rises less than proportionately to income. To overcome this, some of the coefficients in equations 13 and 29 were raised for the years 1980-1990 inclusive (those in #14 were not raised in view of the relatively poor prospective growth of traditional agricultural exports).

Specifically, coefficient B_{13} was revised by about one-third from 0.01851 to 0.02481, and coefficient C_{13} was increased by about 7 percent, from 0.08632 to 0.09204; coefficient B_{29} was increased by about 10 percent from 0.16946 to 0.18600. Thus for 1970-79 the equations for TDIR and TIND were, respectively, #13 and #29, while for 1980-1990 they were

$$\text{TDIR} = -20.89626 + 0.02481\ \text{PNAGFC}(T) + 0.09204\ \text{PAG}(T)$$
$$\text{and TIND} = 53.92574 + 0.18600\ \text{EMGOOD}(T)$$

The effects of these changes were

1. For most simulations they maintained the tax ratio TAXRAT at about its 1965 value of 12.7 percent, whereas in earlier simulations it had fallen by a percentage point or more by 1990; and

2. For many simulations they resulted in the current surplus of the Central Government being sufficient to finance an adequate proportion of the government's development program. Thus, although tax rates in particular areas were raised, the overall tax "burden" remains constant.

Equation 21:

$$CONGNG(T) = b_{21}\,(Y(T) - Y(T-1)) + CONGNG(T-1)$$
$$(b_{21} = 0.125)$$

Regression analysis of past data proved unsatisfactory, since there was a period of five years from 1960-65 when CONGNG hardly rose as GDP increased quite rapidly. In the last few years this pattern has changed markedly, and CONGNG is rising substantialy with Y. The estimate of $b_{21} = 0.125$ is based on a graphical examination of these last few years' experience, which is a period too short to apply regression techniques.

Equation 25:

$$EMINAG(T) = b_{25}(PNAGFC(T) - PNAGFC(T-1)) + c_{25}(XNAG(T) - XNAG(T-1) + EMINAG(T-1)$$
$$b_{25} = 0.07, \quad c_{25} = 0.3$$

This equation provides a good example of the perils involved in unthinking application of regression analysis. Originally the equation $EMINAG(T) = a_{25} + b_{25}\,PNAGFC(T)$ was fitted to the 1958-67 sample period and yielded $a_{25} = -53.5835$ (t statistic = -4.8055), $b_{25} = 0.11534$ (11.6462), $R^2 = 0.9443$ and D/W = 1.7949, all of which were satisfactory. But for 1970 this equation already seriously underestimates the likely EMINAG by some 50 million colones, and the reason for this is rather clearly that the increasing proportion of nonag goods in exports, with their high import content, increases nonag imports at a rate proportionately greater than nonag value added. But one cannot correct this by including XNAG in the regression equation since PNAGFC and XNAG are so highly correlated in the sample period that nonsense results are obtained if one tries it.

To overcome this, use was made of a study reported in the 1967 RRNA memorandum on the balance of payments already referred to, in which a detailed investigation (based on industrial survey data) was made of the import composition of nonag exports. The estimate $c_{25} = 0.3$ is derived from this study. The estimate of b_{25} followed from assuming $c_{25} = 0.3$ and applying the equation to data of recent years, the only unknown then being b_{25}.

For reasons of easier computation, the 1970 value of EMINAG was estimated from the original equation, except that 50 million colones were added to it, so that a_{25} became -3.5835. Thereafter, the main version of equation 25 was used.

Equation 39:

$$PDOMFD(T) = b_{39}\ CONFOD(T) - EMFOOD(T) \qquad (b_{39} = 0.63153).$$

The problem here is one of distributive margins. Given a certain consumption of food (CONFOD) and imports of specialty foods (EMFOOD), the difference between them is the domestic production of food, ignoring stock variations. But CONFOD is valued at retail prices and PDOMFD at farm prices, so some adjustment has to be made. Assuming that EMFOOD has the same percentage mark-up (m) as domestically-produced foods, we have

$$CONFOD = (1+m)\ PDOMFD + (1 + m)\ EMFOOD$$

so that $(1 + m) = CONFOD/(PDOMFD + EMFOOD)$. The average $(1 + m)$ so calculated for 1958 through 1966 was 1.5840, with a low of 1.4629 and a high of 1.7218. The reciprocal of 1.5840 is 0.63153, and is used because from the above equation

$$PDOMFD = (1/(1 + m))\ CONFOD - EMFOOD$$

and $1/(1 + m) = 0.63153$.

Equation 46:

$$STOCKS(T) = b_{46}\ (Y(T) - Y(T-1)) \qquad (b_{46} = 0.05000)$$

Some provision must be made for addition to inventories as incomes increase. The historical series on inventory increase displays too great an irregularity to use to construct an estimate of b_{46}, and the figure used (5 percent) is purely notional, derived in a general way from investigations in other countries on inventory/sales ratios.

IV. Estimates of the Predetermined Variables

The predetermined variables used in the model fall roughly into four groups, although the boundaries between some of the categories, particularly the first two listed below, are not at all sharp. The classification is as follows:

A. Policy Variables

In this category are those variables which constitute the targets for economic policy. Although these cannot be set at any level irrespective of the resources available, there is generally speaking some latitude for setting alternative target levels, and the whole exercise consists in exploring the implications, for many of the other sectors of the economy, of alternative levels of these policy variables. In the present model these variables are ENAG, PAG and Y; to some extent EMFOOD, XAGTR and XNAG are also in this category.

B. Exogenous Variables

Some variables are determined mainly by the working of forces outside the Salvadoran economy, and therefore can be treated neither as endogenous nor as policy variables. Uncertainty about their future behavior is usually considerable, and therefore it is advisable generally to provide more than one projection of each. In the present model these exogenous variables are EL, FLOPAG, POP, TIME, XAGTR AND XNAG. However, these exogenous variables are amenable to alteration by suitable policy decisions; in particular, there seems scope for policy in achieving desirable levels of POP and XNAG.

C. "Quasi-Endogenous Variables"

In this rather catch-all category are those predetermined variables which actually depend directly or indirectly on present and past values of the policy and exogenous variables; but where this dependence is sufficiently tenuous or complicated that it is not feasible to fit the variable into the body of the actual model itself. In this category are DAG, EMFACS and EMFOOD.

D. Lagged Endogenous Variables

For completeness' sake it should be added that the model utilizes as explanatory variables certain lagged values of some of the endogenous variables, which in any given situation are therefore predetermined. Thus, since the model begins in 1970, values for 1969 of CONGNG, FEINSE, PAG, XAGTR and Y are needed by Equations 21, 10, 8, 14 and 46; once these are fed in, the model itself generates the lagged values required for subsequent years (note that, as explained in the account of Equation 25, the determination of the 1970 value for EMINAG does not use the usual form of equation (25), and so does not need 1969 values of PNAGFC, XNAG and EMINAG).

Detailed Description of Predetermined Variables

(1) ENAG:

The basic series on employment in nonagriculture was presented, with a full description of how it was obtained, in an RRNA memorandum of November 10, 1968 on Projections of Employment in El Salvador; the two primary sources involved were (a) the Censuses of 1950 and 1961, and (b) the annual sample surveys of employment in urban areas of El Salvador carried out by the Ministry of Labor.

Three projections of ENAG were made, High, Medium and Low. The High projection assumed a growth rate of 5 percent, considerably higher than the growth rate of the labor force, so that the nonag sector would

make a considerable contribution to expanding employment opportunities in the whole economy. On the other hand, the low projection, at a 3.5 percent growth rate, assumes that the nonag sector will make proportionately no net contribution to the absorption of labor. The medium projection, at 4.25 percent, lies halfway between high and low.

(ii) PAG:

As with ENAG, there are three projections for PAG, high, medium and low. The low projection was that experienced in the past decade, namely 3.3 percent, while the medium projection assumes 4.9 percent growth in the decade 1970/80, and 4.7 percent growth during 1980/90. The high projection assumes 5.5 percent throughout.

(iii) Y:

This variable, which is "producto territorial bruto" (PTB), but at factor cost not market prices, again has three projections, High, Medium and Low. The High specifies growth at 6 percent during 1970 and 1971, and 7 percent thereafter; Medium assumes 5.7 percent throughout and Low, 4.5 percent. For 1967, 1968, 1969, the growth rates assumed are 3.76, 4.13, and 4.50 percent, respectively.

(iv) EL:

Only one projection was used, taken from CELADE: Boletín Demográfico, Año 2, Vol. 3, January 1969, Table 3. Other projections were considered (e.g., those by Carmen Arretx) but since they differed little from the CELADE figures, were not used. This projection assumes that labor force participation rates, by age and sex, stay constant at the levels shown by the last Census (1961). The CELADE figures are given only at five-year intervals from 1960 through 1985; to obtain annual estimates the following implied annual growth rates were applied: 1965/70, 3.08 percent; 1970/75, 3.29 percent; 1975/80, 3.54 percent; 1980/85, 3.58 percent. A figure of 3.62 percent was assumed for 1985/90. Policy

can of course affect EL, but since most of those who will be in the labor force during the next fifteen years are already born, not very much effect on EL can be made during the 20 years under consideration, unless participation rates change.

(v) FLOPAG:

This variable is essentially an attempt to guess at how real wages will rise in agriculture, and hence how the increase in demand for agricultural labor will be shared between increased employment and increased wages. Thus it is assumed that if PAG is at the High projection of 5.5 percent, agricultural wages per man will rise at 2.3 percent per annum; if PAG is rising at 4.8 percent (average), then real wages are assumed to increase at 2.0 percent; and if PAG is rising at only 3.3 percent, then wages will rise at 1.3 percent.

Rather than express this directly in terms of agricultural wages, which do not appear elsewhere in the model (and for which the data are poor), an indirect approach measures its consequences from 1965 as a reference base, for which it is assumed that agricultural unemployment was zero. If this had been the case then agricultural output per man would have been 1013 colones. We then assume that this level would have increased at 2.3 percent, 2.0 percent, and 1.3 percent, respectively, in order to arrive at estimates of how much "excess" unemployment or overemployment would appear. The mechanism for doing this is Equation (54).

(vi) POP:

As in the case of EL discussed above, only one projection was used (the others available being very similar). That used was taken from CELADE: Boletín Demográfico, Año 1, Vol. 2, October 1968, Table 2. Figures are given at five-year intervals from 1965 through 1985, and are here interpolated by the implied quinquennial growth rates in order to arrive at annual estimates. These quinquennial rates were: 1965-70, 17.96 percent; 1970-75 18.92 percent; 1975-80, 19.84 percent; 1980-85, 20.45 percent. For 1985-90, an annual growth rate of 3.84 percent (equivalent to a

quinquennial growth rate of 20.8 percent) was used. This also could be regarded as a policy variable, though the time span of only 20 years is insufficent to give much scope to policy.

(vii) TIME:

The base year is 1955, so that TIME (1955) = 1, TIME (1956) = 2, etc.

(viii) XAGTR:

For this there are three projections, the low projection being taken from an RRNA memorandum on projections of El Salvador's agricultural exports. The projections for coffee, cotton and sugar were used, and interpolated by the quinquennial growth rates implied. Thus for 1965-70, the implicit annual rate of growth in the projections was 1.01 percent; for 1970-75, 3.36 percent; for 1975-80, 2.14 percent; for 1980-85, 2.14 percent; and for 1985-90, 2.07 percent. For the high projection used here, the 1965-70 and 1970-75 rates from the low projection were used, but for the other years another percentage point was added to the growth rate, so that we have 1975-80, 3.14 percent; 1980-85, 3.13 percent; and 1985-90, 3.07 percent. The medium projection was an arithmetic average of the other two.

(ix) XNAG:

Whether exports of nonagricultural products, and services, is an exogenous or a policy variable, is difficult to decide. It is really both since the demand for El Salvador's manufactures depends on developments outside her borders, and depends also on how hard she is prepared to push those exports, in terms of price, quality and service. The rate of growth of XNAG in the last few years has been phenomenal, at around 25 percent during 1962/67, but fell to about 11 percent in 1967/68. The high projection assumes that the growth rate of XNAG will rise from 10 percent in 1970 to 12.5 percent in 1990, while the medium projection assumes that XNAG will grow at 10 percent from 1970 to 1990; the low projection assumes that XNAG's growth rate will

decline linearly from 10 percent in 1970 to 7.5 percent in 1990; whichever assumption is made the growth rate of XNAG will be a major force in El Salvador's economic growth.

(x) DAG:

Three projections of this are provided, corresponding to the three PAG projections. Since so much of agricultural investment goes unrecorded, the base year figure for DAG must necessarily be rather notional. It has been assumed at 25 million colones in 1965, and grows by 5.5 percent, 4.9 percent (1970-80) and 4.7 percent (1980-90), and 3.3 percent, in the high, medium and low projections respectively. This is a far from satisfactory procedure, but it is not a very important variable.

(xi) EMFACS:

This variable, net imports of factor services, was assumed to vary directly with Y. For the decade 1958-67, values of EMFACS were plotted against Y, and a straight line fitted by eye to these data. The appropriate value of EMFACS, for a given Y from a High, Medium and Low projection was then read off from this straight line. This approach to some extent neglects, of course, the effects of past foreign borrowing in building up foreign-held assets.

(xii) EMFOOD:

There are three projections of this, each varying directly with Y. It was reasoned that there would be two influences on the level of EMFOOD, working in opposite directions. On the one hand, rising incomes would tend to pull in more imports of foods not easily obtainable in El Salvador. On the other hand, the rising size of the market, and deliberate policy, would tend to lead to import substitution of some foods. The projections reflect both forces.

A regression of EMFOOD on Y for the sample period 1958-67 yielded the equation EMFOOD(T) = -8.68246 + 0.037327 Y(T), with t statistics of -2.0942 and 14.8750

respectively, R^2 of 0.9651 and D/W = 1.6453. From this equation one may calculate levels for EMFOOD in 1990 of ¢331.8 million, ¢263.6 million and ¢217.2 million, corresponding to High, Medium and Low Y. These levels of EMFOOD would represent, respectively, 3.64 percent, 3.62 percent and 3.75 percent of Y, compared with an average 1965-67 level of 3.28 percent.

It was assumed that by 1990 rather more than one-half of the originally imported food items would have been substituted for by domestic production, so that EMFOOD would represent only 1.5 percent of the projected level of Y in 1990. Intermediate values of EMFOOD for 1970-89 were then read off by logarithmic interpolation between the known 1965 value and the three 1990 values so calculated.

V. Simulation of the Model

In order to perform a simulation of the model, one needs to have: (i) a set of values for the 37 parameters; (ii) a set of projections for the 12 predetermined variables; and (iii) a computing procedure.

(i) Values for the 37 parameters

The set of values used for all the simulations, and the ways in which they were derived, have been described in detail in Section III. It should be noted that there is no reason in principle why alternative sets of values, varying by one, two, three, ... parameter values (up to 37) could not be tried using the same simulation program. This permits a great deal of flexibility; thus one may have doubts about the values of the capital/output ratio assumed for nonag; they can easily be changed, and the consequences of making that change, everything else remaining unchanged, can be quickly and cheaply explored.

(ii) Values for the predetermined variables

The following 9 predetermined variables had three projections each: ENAG, PAG, Y, FLOPAG, XAGTR, XNAG, DAG, EMFACS, EMFOOD, while only 3, namely EL, POP and

TIME had one projection. This raises the possibility of 3^9 = 19,683 simulations! But this number is reduced drastically by the following considerations: (a) the High, Medium and Low projections of EMFACS and EMFOOD depend directly (as already discussed) on whether Y is at High, Medium or Low; (b) similarly DAG and FLODAG are directly dependent on PAG; (c) factors (a) and (b) together cut down the number of variables with independent variation from 9 to 5, and so the number of possible variations from 3^9 to 3^5, or from 19,683 to 243; (d) even this smaller number is reduced still further by requiring that, apart from XNAG which has completely independent variation, no High projection of any variable can be combined with any Low projection of any other variable. The economic reasons for this are obvious; it would not seem realistic to suppose for example, that Y could grow at 7 percent per year while ENAG was growing at only 3.5 percent; and so on. The effect of this set of restrictions is to cut down the 243 previously possible simulations to 93. The computer program must embody a procedure for systematically (and automatically) picking out the correct 93 simulations out of the 19,683 possible.

(iii) Computing Procedure

The computation part of the computer program for the simulations is straightforward and follows closely the sequence of equations set out in Section III. The only complication occurs with equation (7), where in order to compute GNAG(T) one needs to know CAPEND(T). But by equation (5), CAPEND(T) = CAPBEG(T+1), so that in order to compute, say, GNAG(1970) (and many of the other variables in 1970), one needs to know CAPBEG(1971). To compute this, in turn, requires computation of equations (1) and (4) for 1971. Thus the computer program proceeds by computing equations (1) through (4) for 1970 and 1971 before it proceeds to equation (5) and beyond. Thereafter, for subsequent years, the first four equations refer always to year (T+1), while the rest refer to year (T); this is true for T = 1990 also.

The program was written in FORTRAN IV by Stephen W. Schwab for the IBM 7094 computer. Computation proceeds quite quickly; total computing time for the 93

simulations was 1.07 minutes, plus printing time of about 15 minutes. Of course, "debugging" of the initial programs took considerably more time than that.

APPENDIX TO CHAPTER V

WATER RESOURCES FOR AGRICULTURAL PRODUCTION IN EL SALVADOR

WATER RESOURCES POLICY AND AGRICULTURE

PROJECT DESCRIPTIONS AND DETAILS

EL SALVADOR ORGANIZATIONS CONCERNED WITH WATER

LEGAL DISPENSATIONS THAT DIRECTLY OR INDIRECTLY GOVERN THE USE OF WATER, ITS CONSERVATION, AND PROBLEMS OCCASIONED BY ITS EXPLOITATION

PRELIMINARY STUDY OF IRRIGATION, DRAINAGE, AND FLOOD CONTROL PROJECTS IN EL SALVADOR

ZAPOTITAN PROJECT
Project for the Agricultural Development of Zapotitan Valley

ZAPOTITAN VALLEY
Feasibility Report, Agricultural Development of the Zapotitan Valley

RIO GRANDE DE SAN MIGUEL BASIN
Groundwater Research Project

RIO GRANDE DE SAN MIGUEL BASIN
Appraisal Report

UPPER RIO LEMPA BASIN

LA CABAÑA, S.A.

WATER RESOURCES POLICY AND AGRICULTURE

Agriculture benefits from the development and management of water resources and the provision of dependable water supplies for rural uses, livestock, and irrigation, and from flood control and improved drainage. Potential effects of such programs could include (1) more effective use of resources, (2) increased crop production, (3) improvement of efficiency and income of farm enterprises, (4) settlement of family farms, (5) regional and area development, and (6) economic stability. Within a framework of all public investment, program objectives could be classified as (1) to increase consumption, (2) to redistribute consumption, (3) to promote national self-sufficiency, and (4) to fulfill political obligations.[1/]

The formulation of a national policy for the management, development, and use of water resources may be constrained by the nature of public values and institutions. Any national development program must be amenable to the social customs and institutions of the nation. If it is not compatible with these values and institutions, it will not have popular acceptance and will be ineffective. Since changes in social and institutional structure take place slowly, it is necessary to formulate water resource programs so as to minimize disruptions. Thus it is suggested that resource development plans proceed first with those investments requiring the least disruptive change in the basic political and social institutions.

The proposition stated above is strongly relevant to the problem of attaining national economic objectives for agricultural production. Where existing institutions or values resist policies or programs designed to implement g rowth objectives, means must be explored to limit this resistance. To the extent that production goals can be met by programs formulated in this manner there is no problem. A gradual approach toward this end might be implemented through economic analysis of the impacts of natural resource investments throughout the whole economy. If it can be demonstrated that the political and social forces underlying the established institutions would benefit from economically feasible projects for land and water resources development, they would be less likely to oppose these projects.

1/ Stephen A. Marglin, Public Investment Criteria. Cambridge, Mass.: MIT Press, January 1968.

The following is not intended as a complete statement on criteria for establishing a policy for water resource development in agriculture. Nor does it pertain exclusively to agriculture or to water per se. Water as an economic factor is generally associated with other economic factors, such as soils and forests, as well as capital and human resources. The following criteria and analytical requirements are presented as suggested guidelines for formulating a public attitude toward water resources management:

1. Plans should be made and programs started for the collection of basic information on the current supply, quality, and use of water resources.

2. Plans for developing water resource projects for one purpose should recognize the complimentary and competitive effects on other uses.

3. Investments in water resources should be planned to meet particular objectives, and alternative means (including nonwater alternatives) should be considered. A project usually will affect several objectives. These effects -- both favorable and unfavorable -- should be evaluated, insofar as practical.

4. Costs of investment, insofar as feasible, should be borne by beneficiaries in proportion to benefits received, but this criterion should take account of the following:

   a. Ability to pay.
   b. The practicability of identifying those who benefit and the extent of the gains.
   c. The incidence of benefits and costs over time.
   d. Nature of benefits -- public in contrast to private.

5. Programs should be encouraged to assure good water quality, water supply, and conservation through --

   a. Prevention of soil erosion and sedimentation of streams, lakes, canals, ditches, and other waterways.
   b. Prevention of water pollution from effluent of municipal and industrial wastes.
   c. Prevention of salinization of soils through irrigation and from drawdown of groundwater tables.

6. National policy should promote the development and changes in institutions necessary to achieve the objectives of water resource management and projects for development.[1] Following are example of selected problems:

   a. A report of the Food and Agriculture Organization of the United Nations recommends that groundwater control and regulations be established for the following objectives:[2]

      (1) To guarantee that the country's hydraulic resources are beneficially and reasonably used and conserved and that an equitable distribution is made among the different main uses.
      (2) To promote the use of groundwater within the pertinent legal and regulating provisions.
      (3) To establish the conditions under which the investigation of this natural resource is to be conducted.
      (4) To assure that the reserves of groundwater are not wasted, contaminated or altered, and to fix norms to prevent such.
      (5) To control the exploitation of groundwater through permits, concessions, restrictions, and prohibitions.

   b. Review of land tenure system including tax structure to find means of enhancing efficient farm operations. This could involve land transfer arrangements, rental contracts, land taxes, and credit arrangements for land acquisition and farming operations.

   c. Establishment of water districts and organizations for project management and maintenance, including arrangements for reimbursement of project costs through taxation, fees, assessments, etc.

1/ See report of Dr. Dante A Caponera, June 1968, Sobre Aspectos Legales e Institucionales Relativos a la Administración y Manejo de las Aguas Con Fines de Riego.

2/ Groundwater Research Project - Lower Basin of the Rio Grande San Miguel, General Report, 1964. Special Fund, Food and Agriculture Organization of the United Nations, Rome.

7. A program of research should be encouraged to provide continued data on water supply, water quality, irrigation practices and efficiencies, adaptability of crops, etc.

8. As a forerunner to large-scale development, a pilot project for a group facility might be appropriate. Experience in irrigation, drainage, and soil conservation is accumulating through the efforts of META and the technical assistance given to individual farmers. Initiation of larger undertakings, however, requires the cooperation of many individual farm operators and landowners. A small-scale pilot project would be useful for obtaining more technical information and for testing organizational arrangements at the local level. It would also serve as a means of extending information to other areas as yet undeveloped.

Application of Policy Guidelines to Project Planning

Application of policy guidelines to project planning would begin with a discussion of the following functional aspects of project planning: (1) Basic data, (2) watershed management, and (3) plan formulation and economic evaluation, plus questions of program impiementation and research.

Basic Hydrologic and Economic Data

As planning for the development of water resources progresses, it becomes evident that more basic information is necessary. Much has already been accomplished by the GOES regarding rainfall measurement, stream flow gauging, groundwater surveys, g eologic surveys, and the compilation of economic and population data. These kinds of data are required to evaluate the feasibility of agricultural water development plans with a reasonable degree of assurance. An estimation of the influence of irrigation development throughout the nation and its relation to other aspects of economic development requires additional data compiled by watersheds or water regions.

Examples of basic water supply and water use data compiled by water regions can be found in two U. S. publications.[1/] It is

1/ The Nation's Water Resources, U.S. Water Resources Council, Washington, D.C., 1968, and Estimated Use of Water in the United States, 1965, Geological Survey Circular, U.S. Department of the Interior.

suggested that the water supply and water use data presently available to the GOES and the continuing records of such data be compiled periodically by water regions. A very brief summary of the presentation would include estimates of (1) rainfall by season, (2) stream flow by season, and (3) volume of renewable groundwater. The most important uses of water should also be estimated. Domestic, industrial, steam electric power, rural domestic, and irrigation may be the major ones. The amount of data presently available will permit only crude estimates of water supply and use. It would be valuable to take an inventory of the missing data to indicate which instruments and surveys are necessary.

In formulating a national plan for the development of water resources for agriculture, the whole economy and goals for further economic development must provide the setting within which the economic analysis takes place. When considering El Salvador's potentially irrigable land, it is well to keep in mind that irrigation is a very high user of water. In the highly industrialized United States for example, irrigation accounted for 41 percent of the water withdrawn for all purposes in 1965; in terms of water consumed, irrigation used 83 percent of the total. Obviously this situation can give rise to problems in determining the allocation of water for optimal economic use. Considering the potential population growth of El Salvador and the nation's industrial development goals, it is necessary to be aware of the need of the non-agricultural sectors of the economy for water. Economic projections by water resource regions are, therefore, essential to water resource planning.

It is particularly important to project population and industrial development. Estimates of water needs should be projected and compared with the potential water supply. Analyses should also be made of the effect of greater water use on water quality and the increased investment in treatment and disposal of wastes. As El Salvador's population increases and its industrial growth continues at a high rate, the analysis of water supply and use should be an important consideration in the establishment of future economic policy.

Watershed Management

The concept of watershed management focuses attention on the relation of water use to the physical, social, and economic environments. The use and management of land affects the quality

and quantity of water runoff and other hydrologic characteristics of stream flows. Adjustments in land use and management may serve to reduce problems of land erosion, flood control, and water pollution. Water borne sediment and effluent from agricultural and domestic wastes may impair water quality for downstream uses. Usually the water needs for households, cities, industry, and agriculture are limited to the watershed runoff and to its subterranean region. Watershed planning therefore is important to the entire economy.

The Zapotitán Valley Project offers a good example of the potential application of a watershed management approach to planning and development. The project area is situated in the central portion of the watershed of the Río Sucio. Improvements under consideration include irrigation from surface and groundwater sources, drainage, and access roads.

Several questions concerning domestic and industrial needs for water are relevant to management of the Zapotitán project area and of the Rio Sucio watershed in general. How much water is used for these purposes? Where is it obtained? Are shortages of supply experienced during the dry season? What are the expected future needs for water? Are the future needs likely to exceed the potential supply during critical periods? How are the industrial and domestic wastes treated? Do such effluents contaminate the runoff reaching the waterways? Will further water development for industrial and domestic needs affect the planned Zapotitán agricultural project?

Other relevant questions arise concerning the effect of management of the watershed lands on successful operation of the Zapotitán project. What are the conditions of erosion on these lands? Are erosion control measures feasible? Prevention of erosion of road banks and ditches as well as fields may lower the maintenance costs of the proposed irrigation and drainage canals and ditches. Soil conservation practices may also increase the yields of crops and pastures, thereby promoting the same objectives (e.g., increased production, increased consumption, farming efficiency) as those of the Zapotitán project.

Watershed management would also require an analysis of project effects on the reach of the Rio Sucio below the project area. Is periodic flooding presently a problem along this reach?

Under what conditions will the project mitigate or aggravate the flood problem? Will the project add to problems of low flow during the dry season? Will it have harmful effects on water quality?

Plan Formulation and Economic Evaluation

The objectives of water resource development for agriculture in El Salvador take many forms. One is to increase aggregate consumption and to promote national self-sufficiency (Marglin's terminology). 1/ Other objectives may be to increase agricultural production, to enhance farming efficiencies and incomes, and to increase employment opportunities. It is important to recognize that water resource improvements such as drainage, flood control, and irrigation are not ends in themselves; rather, they are means to achieve specified objectives. There are many means of accomplishing these objectives. One criterion for plan formulation should be optimum economic efficiency in the attainment of objectives. Evaluation of alternatives is basic to plan formulation whether at the national level or the project level.

Plan formulation requires an incremental analysis of potential segments of a program to select the combination of segments which produces the greatest net returns. This principle can be demonstrated at the national level of planning. Assume the objective to be an increase in agricultural production, and further assume that water resource investments offer a high potential for increasing production. The GOES is confronted with several large-scale projects that would irrigate more than 200,000 hectares. Now, if an increase in agricultural production is the goal, the principle of incremental analysis might be applied to the potential projects. For example, what would be the costs and returns of flood prevention and improved drainage without the additional investment in irrigation? Are the marginal returns from this segment greater than from the added increments of irrigation? This is not to say that irrigation is not profitable or that investments for irrigation should not be undertaken; rather, it is to demonstrate the process of obtaining optimum economic efficiency in allocating resources for given objectives. It should be noted, however, that a brief study of available data on land and water resources of the nation indicates several land areas that could be improved through flood control and land drainage. It also appears that for irrigation to be effective in many of the potential irrigation projects, drainage and/or flood control would be necessary.

1/ Op. cit.

To carry the analysis a step further to project formulation and to introduce the concept of "secondary benefits," the Zapotitán project serves as an example. Some specific purposes or objectives for developing the Zapotitán Valley might be (1) To increase productivity of the natural resources -- land, water, and forests; (2) to increase total production; (3) to increase farm income, and (4) other indirect purposes, including increasing opportunities for employment, providing settlement opportunities, and enhancing income in general throughout the nation.

Plans for achieving these objectives may disclose conflicts in the allocation of available resources. That is, a plan formulated to maximize any one of these objectives would to some extent affect each of the other objectives. Separate optimizing plans could be made for each objective and the effect of each plan on all others measured. However, the formulation of a single plan to optimize all objectives cannot be done without assigning relative weights of importance to each objective. Thus at the start of plan formulation it is necessary to have at the least an ordinal ranking of priorities. As planning proceeds and more knowledge is gained about costs and returns, adjustments can be made in the balance of objectives sought.

Plan formulation also requires analyses of alternative means of attaining specified objectives. Such alternatives would include: adjustments in land use, improved farming practices by use of fertilizers, insecticides and adapted crop varieties, soil conservation, drainage, flood control, and irrigation. The effectiveness of many of these alternatives is enhanced through combined application; however, for maximization of the stated objectives, alternatives producing the largest marginal returns should be employed first in formulating the project.

Applying this concept further, the scale of the project would be optimal at the point where the returns and costs are equal for the last increment. At this point the excess of project benefits over project costs would also be maximized. The desirability of attaining this equilibrium, of course, is dependent upon many institutional factors and the opportunities for income from other kinds of investments.

A more appropriate term for "secondary benefits" accruing from projects would be "secondary impacts". We are interested

in secondary impacts because they may favorably influence the attainment of certain project objectives. To the operator of land in the Zapotitán project, for example, the increased production is a benefit. The additional amount of labor, fertilizers, seeds, machinery, and other items required for this production increase are costs to him. But, because objectives for investment in the Zapotitán project may include increases in employment and income, these costs to the farmer may be considered in part as project benefits to others. Similarly, some of the costs of project construction and maintenance may be classed as benefits. This variety of secondary impacts is frequently called induced benefits, whereas the farmer's benefits from direct use of the services of the project may be called user benefits (or primary benefits).

Benefits from increased employment should be counted only to the extent that the labor would otherwise be unemployed. If labor is more gainfully employed because of the project, only the net gain should be included. It should be noted that, in spite of the fact that unemployment is very high in El Salvador, all of the additional labor requirements will not be drawn from this supply. Some of it undoubtedly will be those employed in other activities. Similarly, benefits to the firms who supply the additional inputs to farmers should be net of all costs.

Another kind of secondary impact stemming from benefits arises from the additional handling and processing of the goods produced directly from services of the project. Additional employment is generated and additional income is earned from marketing the additional farm production. Here, too, only the net gains should be claimed as project benefits.

External economies are still another source of secondary benefits which may result from resource development projects. Such benefits would arise when goods or services of the project create economic efficiencies in the use of other resources. For example, irrigation in the Zapotitán project may remove much of the seasonal variation in agricultural production. The stability of output may create higher efficiencies in the use of capital and labor employed by processing and marketing firms.

Secondary benefits of the "induced by" and "stemming from" types can be evaluated through use of multiplier coefficients.

Derivation of satisfactory coefficients, however, involves the construction of a complex model of the economy displaying the relationship of sales and purchases among the several sectors. It is not intended to suggest the use of this technique at this time for project evaluation. Rough estimates of the more obvious secondary benefits should be sufficient.1/

The establishment of the economic feasibility of proposed projects should not rest upon the accrual of secondary benefits. The investment of resources in any economic activity will produce secondary benefits. Since resources invested in agricultural projects preclude their use for some other purpose, secondary benefits in that use are foregone or offset. It is useful, however, to recognize the existence of secondary benefits to have some knowledge of their magnitude and to have an idea of their incidence in the economy. These general evaluations will permit comparisons among competing agricultural projects and with alternative investments for nonagricultural purposes. Estimates of secondary benefits accruing to different economic groups will also help to obtain public acceptability and support for proposed projects. They will also provide a basis for cost sharing and an improved public understanding of the broader effects of the projects.

National Administration and Implementation of Programs

A report transmitted by Dr. I. Raúl E. Matamoros2/ is of particular importance to the legal, organizational, and administrative aspects of water resources management and development.

1/ For further discussion of secondary benefits see: J. Dean Jansma, Secondary Effects of Upstream Watershed Development. Unpublished Ph. D. dissertation, Oklahoma State University, Stillwater, 1964; Robert Haveman and John Krutilla, "Unemployment, Excess Capacity, and Benefit-Cost Investment Criteria," Review of Economics and Statistics, Vol. 49, No. 3, August 1967, pp. 382-392; Tibor Scitovsky, "Two Concepts of External Economies," Journal of Political Economy, Vol. 62, April 1954, pp. 143-151; and Arthur Maass, "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions," Quarterly Journal of Economics, Vol. LXXX, May 1966, pp. 208-226.

2/ Asesor Juridico to the Ministerio de Agricultura y Ganadería, 3 de Junio de 1968.

This report contains an analysis of legislative history of water resource management and development in El Salvador. It also indicates the water related functions performed by each of the major governmental agencies.

Because of the many purposes served by water in a nation's economy and because of the numerous physical and temporal attributes of water, it is easy to understand why it is common to find large numbers of separate organizations dealing with individual aspects of water resources. In the report referred to above the following organizations are included among those having important activities in water resources: the Ministries of Interior, Agriculture and Livestock, Public Works, Public Health and Social Assistance, Defense and Economics. Several other agencies of decentralized administration are also included in such programs as domestic water, electricity, colonization, and credit for water resource development. A generalized summation of the aspects of water resources under study or development by the Government of El Salvador would include meteorological and stream flow measurements, subterranean supplies, domestic water, hydroelectric power, health and sanitation, conservation of soil and water resources, fishery, drainage, flooding, irrigation, and ports of rivers and harbors.

In view of the complex nature of water resources and their multiple uses, planning and implementing programs at the national level requires deliberate coordination. Toward this end, the early delineation of hydrologic or drainage basins as units for planning and installing conservation programs would be useful. These units would be established in advance of the preparation of detailed plans for large-scale projects. Within these units or districts, all agencies could participate at an early stage in the development of programs in accordance with water and related resource capabilities. Hydrologic analyses of surface and groundwater supplies and use, along with surveys of soils and their use characteristics, would be brought to bear on the problems of managing and developing the resources of the district. Agencies responsible for administering developmental type activities such as drainage, irrigation, soil conservation, farm roads, and fisheries would benefit from coordinating their plans with the studies of other groups. The districts would also be able to draw upon the services of agencies responsible for credit, extension, technical assistance, and marketing.

The course of action suggested above does not substitute for the establishment of an irrigation and drainage district when plans have been completed for construction of a larger scale project. On the contrary, it might hasten the accomplishment of large-scale projects through the creation of local leadership and local interest in conservation. Increased income to farmers from following improved cropping and agronomic practices and other less costly improvements could provide a more adequate financial base for investment in the more expe-sive improvements. In addition, most of the smaller scale practices are necessary to optimize the returns from irrigation and to reduce the costs of operating and maintaining the channels and ditches.

The creation of districts in advance of plans for detailed works of improvement is not dissimilar to the U.S. experience in soil and water conservation. When the U.S. Government recognized soil erosion as a national menace in the 1930's, the creation of districts was authorized by legislation. Within only a few years nearly the entire country was organized into districts. The planning and installation of soil and water conservation practices has been a continuing process.

Local Implementation

To date, planning and installing large-scale drainage and irrigation projects has been accomplished through national initiative and direction. Several potential projects have passed through varying stages of planning, and construction has been started in the Zapotitán Valley. However, progress has not been sufficient to appreciably affect farm operations. As projects near completion, literally hundreds of farm operators will be affected. The land area involved in the project may be decreed as a District and further improvements undertaken according to a formally structured plan.

The successful operation of a water system requires technical knowledge both in the management of the system itself and in the management and cultivation of the farm lands. District organizations with local representation can provide the means for communication between the two forms of management. It is essential to effective administration to develop local leadership to the maximum.

If a project supplies water for irrigation, a seasonal plan for managing and distributing the available supply will be needed. In preparing this plan, a district manager must collect and compile information from farmers concerning the intended use of their land and need for water. As the irrigation season advances, changes in water supply may call for adjustments in the plan. A well-conceived organization of farmers will be invaluable for facilitating the exchange of information and carrying out the necessary actions.

In addition to the above functions, district organizations can play an important part in effectuating technical assistance for (1) the on-farm use and management of irrigation equipment and facilities, (2) the adoption of improved crop and livestock production practices, and (3) the processing and grading of products for market.

Local organizations and institutions may be used also to implement action in districts that may be established prior to the formulation of specific project proposals. A first task would be to create local interest in soil and water conservation, to develop a recognition of the potential benefits from conservation and development. The construction of large-scale projects may not be intended for the immediate future. Several presently established institutions might provide means for dissemination of information and education in land and water resources. The public schools, news media including television, social and fraternal groups, and youth organizations such as the Boy Scouts and 4-H Clubs are examples of organizations that might participate more fully in this program. To implement an educational program of this type, it would, of course, be necessary to prepare and assemble appropriate subject matter materials such as films and slides, posters, conservation pamphlets, and other publications. It is interesting to note that this approach to conservation education has been and is still being employed by the Soil Conservation Service and Extension Service in the United States.[1/]

1/ For suggestions regarding ways of disseminating conservation information to the public and creating a better understanding of conservation problems and remedial programs, see: Resource Use, Progress and Conservation Needs in some Latin American Countries, by William Vogt, Conservation Foundation, 1250 Connecticut Avenue, N.W., Washington, D.C. 20036, August 1963, second printing 1967.

Cost Allocation

When the benefits from public investments are diffused throughout the society, usually all costs are borne by the government from general tax revenue. However, benefits from investments in natural resources such as irrigation, drainage, and conservation of soil and water are varied in their incidence. Some are widespread among the populace, while others accrue to identifiable beneficiaries. The cost of constructing and operating successful projects also includes investments in human resources. For example, increased knowledge on the part of the benefited farmers is essential, requiring large expenditures in education and training. The manner in which project costs are shared by the nation and the persons involved in the benefited area influences the effectiveness of the project in many ways. The nature of public objectives and priorities is also involved in setting national policy. It is our purpose at this point to set forth some of the relevant factors that may be useful to the Government of El Salvador in establishing cost sharing arrangements.

In order to determine the cost sharing arrangements to be prescribed, it is helpful to classify project tests as follows:

1. Land assessments and rights of way.
2. Construction costs.
3. Technical assistance, education, and training.
4. Operation, maintenance, and replacement of project facilities.

In practice, greater detail would be required, especially for construction costs where differential cost sharing might be desirable for planning and engineering, and for different types of project features such as main canals, drainage and irrigation ditches, roads, agronomic practices, and conservation measures.

A standard commonly expressed by economists is that costs should be borne among beneficiaries in the proportion that their benefits bear to the total benefits. In theory, this arrangement will result in the greatest efficiency in use of resources. The application of this standard, however, is only practicable in part. There are problems of assigning benefits to separate measures and in estimating the joint effects of measures. Also it is difficult to identify the beneficiaries and the extent of their gain. Nevertheless, recognition of the principle may be

helpful in reaching decisions in some cases. An analysis of the expected benefits of projects will provide data useful to the resolution of cost sharing.

The classification of project benefits in the following categories may serve as a guide (other groupings could be developed). It is recognized that quantification in monetary terms for some of the benefits may be impractical.

1. Identifiable benefits to land owners and operators:
   (a) Irrigation-drainage, agronomic and cropping practices.
   (b) Some soil conservation practices.
   (c) Water supply for nonagricultural uses.

2. Less identifiable beneficiaries--generally widespread:
   (a) Flood control.
   (b) Access roads.
   (c) Resettlement on small plots of land.

3. Impacts of increased agricultural production on the national economy as a whole;
   (a) Improved export-import balance.
   (b) Increased domestic demand by farmers for products and services of other sectors of the economy.
   (c) Higher gross national product and increased national revenue.
   (d) Increase in employment of persons otherwise unemployed or underemployed.

In an analysis of the costs and expected benefits of a water resource development project, it is useful to estimate how much of the costs are chargeable to the major purposes of the project. Assume that the latter estimates are made, and the total costs required for the purpose of irrigation and associated drainage are known. There remains the problem of determining the amount of charges to be assessed against the individual beneficiaries and the method of repayment over time. Many factors are involved in resolving this problem, some of which cannot be anticipated in advance of a specific project.

To be established at the start of the project, however, is a set of objectives. Normally, increased production is uppermost, but there may also be a desire to provide farming

opportunities for more proprietors than allowed if the supply of available land were divided into operating units of efficient size. It may also be desired to increase the production of certain crops relative to others. The public interest in irrigation may be of such nature that some of the costs of irrigation should be borne by the Government. If this is the case, how is the subsidy to be shared among the benefited farmers? Should it be shared in proportion to the amount of land held by each operator or by some system which favors the small operator and those farmers with lower repayment abilities? No system of cost allocation can be instituted to implement these several desires precisely. It is suggested, however, that the system be based on the assumption that the desired goal is to increase production on farm units of economic sizes, and that the full cost of the irrigation project including expected costs of maintenance will be borne by the benefited farmers. Then, if other project goals are desired, adjustments can be made in the basic system.

In accord with this approach, it would be necessary to classify the lands in the district to appraise the relative potential gain in productivity. If the potential gains in productivity are generally comparable throughout the area, the per hectare quota of cost can be computed readily. If productivity gains are significantly higher or lower on some lands, an adjustment in the quota would be possible.

As an aid to the development of a plan of repayment, it might be useful to estimate the expected benefits or the net income that corresponds to the prorated costs. This might be done for a few typical farms of different sizes and types within the district. The amount of increased income received by the farmers in relation to their share of the costs will substantially affect their ability to discharge their financial obligations. During the early years while farmers are making additional capital investments and adapting their operations to the new system of farming, their profits will be minimal. But, after a transitional period of years when these improvements have been achieved and when the effects of technical assistance have been realized, the ratio of benefits to allocated costs may increase rapidly. Under these conditions it might be feasible to charge farmers an amount exceeding the project costs.

On the other hand, an analysis of farm income on some types of farms might reveal very meager returns in excess of charges. Obviously there will be considerable variation in farm income and per hectare income throughout the district. Many factors will contribute to this variation, including farm size, kinds of crops and livestock, managerial competence, and other attributes of farm management. Other factors, however, may include the effectiveness of the drainage and irrigation systems on the individual farms benefited and the types of soils. On some pieces of land, the topography may inhibit the potential benefits from irrigation or drainage. Land leveling or other investments may be required. In fixing the charges to be paid by farmers, knowledge of these variations in income and the causes thereof may be of great importance.

Technical Assistance and Other Aids

Adequate technical assistance to farmers within the districts for irrigation and drainage and for soil conservation is of paramount importance. Availability of trained workers for this purpose, and a program to obtain an adequate staff are required. A policy for developing water resources would be remiss if it did not recognize the important role of technical assistance.

A similar situation applies to the need for agricultural credit in implementing the project objectives. Farming under conditions of irrigation and improved drainage, requires larger capital investments. Without the additional investments the potential benefits will not be realized. As with technical assistance, fuller treatment of credit needs is given elsewhere.

Other problems that influence the effectiveness of water resources development for agriculture are concerned with land tenure. Irrigation, drainage, and conservation offer opportunities for increased land productivity, increased production, and increased farm income. But there must be incentive for the exploitation of these opportunities. The nature of rights to the use of land and the share of production influence the behavior of both landowners and land operators. This subject is discussed in detail in the agricultural sector analysis.

Evaluation of Program Performance

The foregoing discussion has been concerned with planning and implementation of programs for water and related land resource management and development. Looking to the future, it is worthwhile to consider the need for post-evaluation of projects. Evaluation of the effects and the administration of installed projects can be helpful in many ways:

1. To appraise the operation of project features, such as canals, ditches, and drains, with respect to their physical effectiveness.

2. To verify the ex ante estimates of effects of project measures on land use, production, and income.

3. To determine the effectiveness of district organization and administration in achieving objectives of the project.

4. To observe the effects of project operation on water supply, water quality, and soil characteristics that may be detrimental to attainment of project purposes.

5. To provide technical information that will be useful in planning and implementing other projects.

6. To serve as a demonstration of the economic and social returns from water resource development and to provide infcrmation useful to the creation of local interest in other areas.

PROJECT DESCRIPTIONS AND DETAILS

Current Progress - Plans, Studies, Organization

Irrigation, drainage, flood control, land reclamation, and soil and water conservation are not new concepts in El Salvador. In fact, the individual and combined impacts of these factors on the national agricultural sector have occupied the attention of public officials for a good number of years. However, it has only been in recent years that the importance of the effect of these factors in the solution of national economic, social, and political problems has been fully appreciated.

An analysis of the potential impact of hydraulic projects on the economy of El Salvador should begin with a resume of what has been accomplished to date in this very broad and important field. A chronology of events is followed by a more detailed outline of the more important studies and investigations.

Chronology of Project Studies

During the 1940's the GOES considered ways and means to improve the situation in Zapotitán, a swampy area having great potential for increasing agricultural production through a program of adequate drainage and flood control. These efforts were finally crystalized in the form of a proposal submitted by the National Agronomy Center (CNA) in 1947. The proposal included a drainage project of 115 square kilometers and a diversion dam to surface irrigate 4,000 hectares divided into two systems. Even though the project was received with great enthusiasm, it did not get past the proposal stage until much later.

Towards the end of 1948, the GOES initiated the preparation of a national irrigation law. The proposed law which was presented the following year, covered the legal, institutional, and other pertinent aspects of a national policy on irrigation. This proposal, in spite of the fact that it was requested by the Executive Branch, was never implemented.

Between 1951 and 1957, at the initiative of the President, a permanent organization called the Inter-Ministerial Rural Committee (CIR) was established to take appropriate action on such pressing rural problems as minimum salaries, land rental agreements, housing, labor conditions, idle lands, and other problems of a social and economic nature. Even though founded on high ideals, this Committee has not produced any concrete results to date.

In 1956, a contract was signed with the consulting firm Tippets, Abbet, McCarthy, and Stratton (TAMS), to study and define the future role of irrigation on a national scale. This study covered six principal areas of irrigation potential dispersed throughout the country.

TAMS presented a new project for Zapotitán that included land reclamation and flood control as well as irrigation. Even though this project was apparently much more viable than any which had been previously submitted, much time would elapse before a project would be formally initiated in this area. It did result, however, in the subsequent commissioning of a Dutch consulting firm to prepare final plans for a combined drainage, irrigation, and flood control project in Zapotitán.

From 1954 to 1958 a diversity of problems in the use and control of public waters, such as the periodically recurring problem of the use of the Río Acahuapa in San Vicente, caused the MAG to devote a great deal of attention to the management of public water. MAG even proposed a commission of three lawyers and two agricultural engineers to develop legislation that could serve as a General Water Law or Water Code and cover all uses of public water, but especially irrigation. A draft proposal for a law for the creation of irrigation districts was presented by the commission, but no further action was taken.

In June 1960 a joint memorandum was presented to the President by the Ministries of Foreign Relations, Treasury, Agriculture and Livestock, and Economy. The memorandum emphasized the critical importance of two programs: (1) Supervised agricultural credit and (2) the development of irrigation and drainage. It was recommended that these programs be given top priority in the use of funds generated under Title IV of P.L. 480 of the USA. A program of supervised credit was launched within a period of two years, but nothing was done with respect to irrigation and drainage programs.

During 1960 and 1961, the Dutch consulting firm, Grontmij de Bilt, prepared a new Zapotitán project for the integral development of the entire valley. This effort was in response to one of the recommendations of the TAMS report. A loan for the ₡7 million required for the project was requested from BID. The loan request was approved by BID, but the National Congress refused to ratify the loan on the grounds that the terms were unfavorable to the GOES, and the Zapotitán project again was returned to the files.

In 1961 the Law of Drainage and Irrigation was passed by Congress. This law created an autonomous and decentralized authority to carry out hydraulic programs for the country. However, from the date of its promulgation the Law has only been in effect theoretically and the autonomous organization created by it has never been allowed to function.

In 1961, and again in response to one of the recommendations of the TAMS report, the GOES in combination with the FAO and the UN Special Fund undertook a complete groundwater investigation of the lower valley of the Rio Grande de San Miguel. A result of this program was the recommendation to establish an irrigation project covering some 10,000 hectares and costing about ¢9 million. The study, which covered all phases of groundwater basin investigation and was considered to be technically complete and reasonable in scope, cost more than ¢2 million.

In 1963 the project for the improvement of agricultural lands (META) was prepared and put into action. The program, which covered irrigation, drainage, and soil conservation, was financed with a loan from USAID and was directed towards the medium-sized farmer. Equipment and personnel were organized for the program, but it has yet to make a marked impact on the agrarian picture of the nation. Perhaps its greatest drawback is the fact that all development loans must be negotiated through commercial banking channels, sources which are notorious for their lack of interest in working with the small and medium-sized farmer. At the present time META still exists, but practically all of the technical work in connection with its projects is performed by the Dirección General de Recursos Naturales Renovables (DGRNR).

During 1963 and 1964 an ad-hoc commission composed of members from the Ministries of Justice and MAG and the Supreme Court was organized to formulate a Law of Drainage and Irrigation. Such a law was finally redacted, but due to vacillation and other problems, it was never presented to Congress.

In 1964 another attempt was made to write a project for a Law Creating Rights-of-Way for Works of Irrigation, Drainage, and Soil Conservation. The Law was written and sent to the Ministry of Justice, but for reasons unknown it never reached a legal status.

In 1965 and 1966 the present project of a Law of Irrigation, Drainage, Land Reclamation, and Soil Conservation was redacted and presented to Congress. The Law, which thoroughly covers the four principal themes, is now under study for constitutionality and legality by a Legislative Commission, where it has been for several years.

Since 1959 MAG has carried out a series of technical and administrative projects covering the training in civil engineering, hydraulics, and irrigation and drainage of various technicians in such countries as Holland, France, Mexico, Venezuela, and the United States. Many stream gauging stations have been established on the principal rivers of the nation.

A Department of Hydrology has been established in the DGA and the Dirección General de Obras de Riego y Drenaje has been established. In 1967 an agreement was signed with UNSF for the improvement and enlargement of the hydrological and hydrometeorological networks of the nation (within the basic Central American program of the UNSF).

Preliminary feasibility reports have been completed by Harza Engineering International--A. Garcia Prieto--for Zapotitán, Sonsonate-Banderas, Bajo Lempa, Alto Lempa, and Rio Grande de San Miguel. In addition, A. Garcia Prieto has also prepared a detailed plan for the irrigation development in La Cabaña, and DGORD has prepared a groundwater development plan for Usulután-Vado Marin. All of these projects are large scale and call for tremendous investments of public funds.

A preliminary map showing the location of all potentially irrigable lands within the nation has been prepared. A national Land Capability Map and corresponding descriptive literature has been completed. A map describing all of the physical features of the principal drainage areas of the nation is available.

As previously indicated, many areas of the nation have been studied in some depth in an attempt to establish the feasibility of irrigation, drainage, flood control, or land reclamation projects that have been proposed One of the purposes of this appendix is to analyze the existing studies. Recommendations on the order of priority for development appear in the main volume of the report.

EL SALVADOR ORGANIZATIONS CONCERNED WITH WATER

Organizations concerned with some aspect of water administration are the following:

(1) The Executive Office. The National Council for Planning and Economic Coordination (CONAPLAN) as established by Art. 4 of Law 59 of 1962, is responsible for recommending to the President medium and long-term goals for the development of the nation's water resources.

(2) Ministry of the Interior. This Ministry is empowered by Art. 5 of Law 137 of 1948 to grant permission to the Executive Commission for the Rio Lempa (CEL) to enter private land for study purposes, even if the property owner is not in agreement. The Ministry may also permit private landowners to perform channel improvement work as long as it involves the return of the river to an existing channel from which it has deviated. The National Emergency Service established by Law 302 of 1965, is responsible for mitigating the effects of droughts or floods. The departmental governors, who are under the control of the Ministry of the Interior, by Art. 17 of the Agrarian Law, are responsible for the inventory of navigable rivers and those that might be useful for irrigation and generation of hydroelectric power, and for the regulation of the use of fishing nets in the absence of adequate control at the municipal level. The municipalities, according to the various articles of the Agrarian Law, are responsible for regulating the use of public waters as long as there is no conflict with other legislative or executive decrees.

(3) Ministry of Agriculture and Livestock (MAG). Art. 34, Decree of Internal Regulations of the Executive Branch (1958) attributes to this Ministry the functions of planning, directing, and supervising programs of soil conservation and land reclamation, the drainage of swamps and use of rivers for agrarian purposes, and the regulation of the fishing industry. Uses of public waters other than for agriculture must be coordinated with either the Ministry of Public Works or the Ministry of Economy, as the case may be. The General Directorate of Economics and Planning is responsible for planning and coordinating programs related to irrigation, drainage, flood control, etc. The General Directorate of Investigation and Extension (DGIEA) handles the control and protection of fishing. The General Directorate of Renewable Natural Resources (DGRNR) is responsible for soil and water conservation; technical assistance for on-farm irrigation projects through the META program; for meteorology, climatology, and hydrology through the National Meteorological Service (SNM), which was formerly under the Ministry of Defense; and stream gaging activities. The General Directorate of Irrigation and Drainage Works is responsible for large scale irrigation and drainage works, flood control and land reclamation. The META program, which is nominally assigned to the DGRNR, is an AID-financed credit fund established in the Central Bank to discount approved loans for small irrigation projects that have been negotiated through private banks. Its functioning will be discussed in more detail in a later section covering credit sources for irrigation and drainage projects.

There is some duplication of effort in META and DGORD that will be discussed below. Except for this problem and the problem concerning credit facilities, which will also be discussed later, the institutional arrangements to handle the use of water for agricultural purposes appear to be well-organized. Integration into a national program, once the proposed legislation is promulgated, will be no serious problem. One area that requires special and immediate attention, however, is the greatly expanded need for research and the provision of technical services that will accompany the future development of irrigation projects. The DGRNR and DGORD should take appropriate steps to resolve this problem before it becomes critical.

(4) Ministry of Public Works. Article 31 of the Decree of Internal Regulations of 1958 charges this Ministry with the responsibility for hydrological studies and map-making. The Department of Planning and Coordination plans such activities. The General Directorate of Urbanism and Architecture (DUA) authorizes urban expansion only after problems of adequate water supply and sanitary and storm sewage disposal have been solved. The Center for Geotechnical Studies and Investigations (CEIG) is responsible for the preparation of geologic and related maps, including water resources.

(5) Ministry of Public Health and Social Assistance. This Ministry is responsible for the collection of information basic to the formulation of sanitation plans. This includes potable water, drainage for insect control, storm and sanitary sewage disposal, etc.

(6) Ministry of Economy. This Ministry, under the terms of Decree 386 of 1961, controls and supervises producers of electricity that generate more than 50 KW, and all producers for public sale. The ministry also approves the electrical rates and the water rates established by ANDA.

(7) Ministry of Defense. National Guard. By Articles 72-75 of the Decree of 1902, the National Guard is responsible for the safety and conservation of all bodies of water and for the enforcement of all fishing laws and regulations. Port captains, who are a part of this Ministry, are in charge of policing all rivers and ports, according to Articles 145-187 of Law 236 of 1933.

(8) Controller General of the Republic. This organization's connection with water is through its audit responsibilities towards the public treasury and the budgets of all decentralized public institutions.

(9) The Judicial Power. Civil judges under the power granted by several different decrees have the right to condemn land for any rights-of-way required by either ANDA or CEL.

(10) National Administration of Aqueducts and Culverts (ANDA). Articles 2 and 3 of LD 34 of 1961 charge this autonomous organization with the responsibility for planning, financing, constructing, operating, and maintaining potable water systems throughout the nation, and also for handling sewage effluent. This organization appears to be adequate to handle the administration of water for both domestic and industrial use.

(11) Executive Commission for Hydroelectric Development of Rio Lempa (CEL). Law 137 of 1948 authorizes this agency to construct development projects and to use the national hydraulic resources to produce power and to supply both power and water to rural and urban zones for agrarian, industrial, and community uses. This duplicates the efforts of both MAG organizations, which are dedicated to the supply and management of such water exclusively for irrigation and drainage.

(12) Institute for Rural Colonization (ICR). Under Law 112 of 1950 and 342 of 1961, the Institute is committed to the construction and improvement of irrigation, drainage, and potable water works.

(13) The Mortgage Bank. Article 103 of the Law of 1936 authorizes this bank to grant credit for more than three years for irrigation and drainage improvements.

(14) The National Administration of Drainage and Irrigation (ANAR). This institution was created by law in 1961, and was given all the powers necessary to develop and administrate national irrigation and drainage projects. The organization was never created and does not exist in actual practice, although the law was never nullified and theoretically is still in force.

(15) An ANDA (see 10) committee meets on problems related to the use of groundwater for the metropolitan area of San Salvador. It includes representatives of the Ministerio de Obras Públicas, CONAPLAN,

Estudios Geotécnicos, Instituto Geográfico Nacional, Ministerio de Salúd Pública, CEL, Ministerio de Agricultura, the regional representative of the United Nations, and the representative of the Government of El Salvador to the project.

(16) A consultative committee for the Central American Hydro-Meteorological Program is composed of representatives of the meteorological services, hydrological resources department of MAG, DGRNR, ANDA, CEL, and the DGORD.

With some adjustments and needed consolidations of responsibilities, the institutional arrangement for the handling of irrigation, drainage, soil and water conservation, and land reclamation projects could be considered adequate. However, this is conditioned upon the promulgation of legislation that will enable these institutions to carry out some of the basic steps required of a rational program of exploitation of the nation's water resources.

Integration of META and the DGORD

The functions of the DGORD and META can be differentiated as follows: The DGORD is responsible for the planning, designing, and development of water resources for irrigation on a national level, whereas META is engaged exclusively in on-farm development of irrigation and drainage improvements.

META has its own technical staff supplied by the DGRNR and owns and operates construction equipment for land leveling and related construction. The DGORD has no construction unit, but contracts this work with private companies. Although META and the DGORD engage in closely related activities, there is no communication, not to speak of cooperation and coordination, between the two organizations.

The natural sequence would be for the DGORD to bring water to the farm boundaries and META to develop

the on-farm systems for utilizing the water. In fact, these activities are so closely associated, META should be converted to an on-farm development division of DGORD.

The DGORD should continue to seek to contract irrigation and drainage work with private constructors. However, it will need a construction unit for the maintenance of the operating systems. The Zapotitan project is its first large development. As its scope of work increases, it may be increasingly difficult to find private contractors to handle all of the work. If this should occur, the DGORD should be prepared to undertake this work with its own equipment.

The on-farm division would need to have the capability for land leveling and constructing unlined earth canals, small drains, mold structures for culverts, and on-farm roads.

LEGAL DISPENSATIONS THAT DIRECTLY OR INDIRECTLY GOVERN THE USE OF WATER, ITS CONSERVATION, AND PROBLEMS OCCASIONED BY ITS EXPLOITATION

(Translated from Estudio de Factibilidad de Desarrollo Agricola Usulután-Vado Marin, Vol. 1, MAG, DGRD, Julio de 1968.)

Legal document	Articles	Contents
National Constitution (8/1/1962)	2, 8, 47 par. 8, 78 par. 12, 122, 135, 137 par. 3, 138, 145, 149, 205, and 208	Right of citizens to health and economic welfare. State ownership of subsoil. International Agreements. Legislative approval of budgets of functionally decentralized organizations. Regime of economic freedom subordinate to justice and social interest, private property as a social function. Expropriation for the supply of water or electrical energy. Development and protection of the economic associations that increase the national riches through

Legal document	Articles	Contents
		a better use of national resources.... Limitation to 50 years for concessions for wharfs, canals, and works of public utility.
Civil Code 1860	571, 576, 577, 581, 834/836	State property, ownership of water, development of water by property owner, right-of-way for aqueducts.
Commercial Code	476/769	Commercial navigation (boats, persons, contracts, risks and accidents, damages).
Mineral Code (1922) ref. L 930 (16/1/1953)	16, 27 item 6, 55 par. 2, 66/67 7 73, 75	Water that arises in the interior of mineral developments radius of protection of dams and public water. Flooding of mines. Rights-of-way for drainage and aqueducts.
Penal Code	268, 272, 273, 534 par. 60	Poisoning or contamination of water or pollution of water.
Sanitary Code	30, 38, 39/41, 49, 51/60, 64 116, 117, 121/122, 182, 224, 249	Regulation of constructions, drainage of houses, sanitary conditions in collective housing, opening of urban streets, protection of aqueducts, dams, or reservoirs, suggestion for discharge of sewage and the

Legal document	Articles	Contents
		means for doing so, and storm waters and industrial waters.
Police Law		Protection of sources and channels of water.
Agrarian Law 28/8/1941	152, 153, 182/ 199, 19	Road or trail crossings of aqueducts. Dumping water on roads. Use of public water; fishing.
Agrarian Development Law (D.L. 518, 27/11/1961)		Grants privileges of irrigation and drainage developed in a cooperative form.
Electrical Service Law (L.177, 31/12/1935 L. 18/9/1948	2, 80	Concessions for hydroelectric work and permits for agrarian or domestic uses. Creation of the Hydroelectric Executive Commission of River Lempa.
Legislative Decree 341, 17/10/1961		Creation of the National Administration of Aqueducts and Drainage (ANDA)
L. 11/12/1961		Does not apply to drainage and irrigation.
Legislative Decree 194 of the Revolutionary Government 13/17/1949		Nationalize the sources of ground water.

Legal document	Articles	Contents
L. 18/1/1956		Defense against malaria.
L. 236 (23/16/1931)		Navigation and maritime affairs.
Urbanism and Construction Law		Urbanization projects: resolution of problems of potable water, complete drainage of sanitary and storm sewers; and the specification of materials to be used in storm sewers and potable water projects.
L. 50 (27/4/1949)		Protection of the shores of lakes and lagoons.
D. 26 (23/2/1912)		Permits and concessions to use waterfalls and take out water. Superseded by Law of Electrical Service and law creating ANDA.
D. 142 (13/10/66)	1 and 2, par. a and g.	Creation of Economic Development Fund for the financing of projects of irrigation, drainage, soil conservation, fishings, and other.
L. 302 (4/6/1965)	3, par. g and e	Functioning of National Emergency Service in case of drought or floods.
L.25/7/1939		Expropriation and occupation of property.

Legal document	Articles	Contents
Regulation of importation, distribution, and use of chemical products for the agricultural industry.		Contamination of water.
L.20/12/1934	1030	Loans from Mortgage Bank for irrigation and drainage for periods of more than three years.
L. 59/62	4	Creating the National Planification and Economic Coordination Council (CONAPLAN).
L. 547	128	Intervening in the handling of the budget of CONAPLAN.
D.99 (17/11/1958)		General regulation of irrigation
	11/19 and 75/82	Regulations of roads, causeways, and public bridges that impose measures to avoid damage by water.
D.20/5/1903	1, 3, 4, 7, and 8	Regulations for unsanitary establishments that prohibit the contamination of water courses.
D.26/9/1912	72/75, 118/ 119, and 229	Regulations of the National Guard that charge them with the responsibility of

Legal document	Articles	Contents
		guarding bodies of water and prohibiting destructive fishing.
D.30/3/1916	2, 5, and 6	Regulations for the disposition of cyanide residuals, the drainage and disposal of metalurgical industries.
D.27 (23/3/1945)	21	Prohibit water contamination with insecticides.
	Regulations Approved by the Executive Power	
30/1/1914		Irrigation in the city of Atiquizaya.
17/8/1927		Irrigation in the jurisdiction of Metapán.
29/9/32		Irrigation in the village of Nahuizalco.
11/4/1932		Irrigation in the city of Izalco.
12/1/1933		Irrigation in the jurisdiction of San Juan Opico.
2/7/1934		Irrigation in the city of Izalco (modifying Regulation dated 11/4/1932).
13/5/1938		Irrigation in the jurisdiction of Zacatecoluca.

Legal document	Articles	Contents
10/6/1941 and 14/8/1941		Irrigation in the city of Izalco (further modification).
22/10/1942		Irrigation in the rivers Sensunapán and Ceniza.
7/1/1948		Irrigation in the city of Usulután.
30/2/1957		Irrigation in Ciudad Arce.
14/8/1957		Irrigation in the Río Mojaflores.
4/2/1959		Irrigation in the Rio Gualohe.

PRELIMINARY STUDY OF IRRIGATION, DRAINAGE, AND FLOOD CONTROL PROJECTS IN EL SALVADOR

Tippets - Abbett - McCarthy - Stratton (TAMS), November 20, 1957

This is a report, on the reconnaissance level, of the irrigation, drainage, and flood control requirements of the entire country. A total of six areas were selected as having a potential for this type of development, and were surveyed in some detail.

Area I - The coastal plain between the Río Paz on the west and the Río Grande de Sonsonate on the east.

Area II - The coastal plain between the San Salvador-La Libertad Highway on the west and Río Tres Amates on the east. This area was selected so that the possibility of using the outflow from Lake Ilopango could also be investigated.

Area III - Lower Lempa River Valley between the Guayabo Dam and the mouth of the river, including the coastal plain between Río Tres Amates on the west and Río La Poya on the east.

Area IV - Río Grande de San Miguel Valley from above the city of San Miguel to the sea. Included was the investigation of the possibility of using the Olomega Lagoon as either a storage or a control basin.

Area V - Río Sirama Valley in the Department of La Unión.

Area VI - Río Sucio Valley from San Andrés Valley, and Zapotitán Basin to the discharge into the Río Lempa.

At the time of writing of the TAMS report, very little information was available on groundwater or stream flow in El Salvador. However, a general statement was made that El Salvador has enough rainfall to take care of all its domestic, agricultural, and industrial needs if it all could be channeled to beneficial uses. (However, one of the conclusions presented at the end of the report was that the quantity of water that could be used for irrigation is limited by the physical and climatic characteristics of El Salvador, and that the extent to which irrigation may be used to increase agricultural production will be determined more by the availability of water than by the amount of irrigable lands.)

Some of the general conditions and assumptions established for the report were as follows:

1. Three irrigation land classifications were established:

   Class I. No restrictions, slope less than 5 percent.
   Class II. Few restrictions, slopes up to 8 percent.
   Class III. Poorly drained land.

2. A net annual benefit or less than $65 per hectare placed a project in the doubtful feasibility class.

3. Engineering and economic factors were the only criteria in the study.

4. Economic analysis was limited to basic and traditional crops; conceivably, other crop varieties could give larger benefits.

   a. Corn. The nationwide average was taken as 15 qq/manzana, although improved practices with hybrid seeds on irrigated land can produce from 50 to 75 qq/manzana. The lower figure of 50 qq/manzanas was used in this report, with no production increase expected from irrigation.

   b. Beans. The national average was taken as 12 qq/manzana, although improved practices in nonirrigated lands produces from 20 to 30 qq/manzana. The lower figures of 20 qq/manzana was used in this report, without taking into consideration additional benefits expected from irrigation.

   c. Cotton. The national average was 10.5 qq/manzana. The large producers get 12 to 15; that used in this report was 12qq/ manzana.

   d. Rice. The national average was 15.5 qq/manzana for dry cultivation, although improved practices and seed produce from 25 to 30 qq/manzana. The figure 25 qq/manzana was used in this study for rice grown in rainy season without flooding, and 45 qq/manzana was used for areas with flooding.

   e. The average net income for areas studied in the report (well-developed lands, good seeds. fertilization, and good management) and for the crops listed is shown in table 1 1/.

5. The water demand was estimated to vary 2.5 cm. between the minimum and maximum months.

1/ All tables referred to are found at the end of this review of irrigation studies, following page 97.

6. Consumption of water was estimated at 5 times the maximum monthly use of 15 cm., or a total of 75 cm. Diversion demand was then doubled, giving a total demand of 150 cm./month.

7. Potential irrigators in the coastal plains areas and the Rio Grande de San Miguel Basin need instruction in water management and application. It must be stressed that, indispensable for successful irrigation are the manner and amount of application and adequate drainage.

Area I

Area I totals roughly 15,000 hectares, and it is one of the least densely populated areas of El Salvador. At the time of the report, only 500 to 600 hectares were in cultivation and practically all was for local consumption. No doubt the completion of the Carretera Litoral in this area has changed this picture quite radically.

The entire area is characterized by coastal sand dunes backed by tidal swamps. Fresh water swamps also are typical of the area, especially in the rainly season.

The main source of water supply is the Río Paz (which must be shared with Guatemala) and the Rio Grande de Sonsonate and its tributaries. No flow information was available for the Río Paz, but the minimum dry-season flow was estimated at 3 liters/sq.km., or a total discharge of 5 cu.m./sec. This was at El Jobo where the drainage area is 1,400 sq. km., and where there is a potential dam site which would be adequate for both hydroelectric power and irrigation development. Flows from springs farther downstream are estimated to increase the minimum flow at the mouth to 6 or 7 cu.m./sec.

Most of the small rivers between the Río La Paz and the Rio Grande de Sonsonate go dry during the summer months. At the time of the report there were no flow data available, but it was estimated that even those rivers fed by many springs had a minimum flow that did not exceed 1.5 liters/sec./ sq.km. The waters of the Rio Grande de Sonsonate and the Rio Ceniza to the east are being used for irrigation to a large extent, so that there is little hope of expanding irrigation through the use of the water in these rivers. The principal tributaries of the Río Grande de Sonsonate have been gauged intermittently for as far back as 1928, mostly by the electric power companies of El Salvador, but none of the records are continuous or cover all phases of the river flows.

Future development in this area is more closely associated with land reclamation and irrigation than with any limitation imposed by the soils. The lack of roads was an important consideration at the time of the report, but this has since been alleviated somewhat by the construction of the Carretera Litoral.

Between the Río Cauta and Acajutla are scattered areas that can best be developed by private landowners. Some 500 hectares can be economically recovered in this area by surface drains, channel improvement, and pump drainage, at an estimated cost of $600 per hectare.

The production of 3,500 hectares west of the Río Cara Sucia could be improved and possibly extended to 6,500 hectares through drainage and channel improvement. This could cost as much as $800 per hectare, and an investment of this magnitude could only be justified by low-interest loans and long-term amortization of the capital investment.

It was estimated that channel improvements to the Ríos Paz, Grande de Sonsonate, and Cara Sucia would amount to some $1.8 million, and that auxiliary improvements such as gravity and pump drainage would cost an additional $3.25 million, giving a total of $5.05 million. Since the improvement of some 6,500 hectares of land would be involved, the unit cost would be about $780 per hectare. To this capital investment cost must be added another $60 to $70 per hectare for annual operation, maintenance, and amortization charges. No benefit figures were available, but the other adverse conditions of the area would serve to keep them lower than for other parts of the nation.

There is no doubt that irrigation and drainage would be of much benefit to the area, but the question is where and how to start. Recommendations advanced in the report, in order of priority, were as follows:

1. Initiate a 100-hectare pilot drainage project, keeping close check both on costs and on benefits.

2. Make a detailed drainage study of the entire area.

3. Initiate a joint study with Guatemala on the regulation and use of the Río La Paz. It was estimated that the minimum dry season flow would be adequate for the irrigation of some 5,000 hectares on both sides of the river.

4. Undertake a progressive program of installation of drainage in the entire area up to the economic limit.

5. Urge private landowners to undertake individual irrigation projects using either surface or groundwater resources.

Area II

This is a triangular area, with the apex in La Libertad, bounded on the north by Carretera Litoral, on the east by the Río Amates Valley, and on the south by the Pacific Coast. The length is about 60 km. and the width varies from practically zero at the apex to 20 km. at Río Amates. The total area is about 50,000 hectares. The broken topography of the land north of the Carretera Litoral makes irrigation impractical except in isolated circumstances.

For purpose of the study the area was subdivided into three regions: (1) An area of about 500 hectares between La Libertad and the Río Comalapa; (2) an area of 10,000 hectares between the Rios Comalapa and Jiboa; and (3) a 35,000-hectare unit between the Rios Jiboa and Amate. The need that was common to all three regions was drainage, an improvement that would both increase land values and production potential.

The main river in Area II, and probably the only one with potential for large-scale irrigation development, is the Río Jiboa. The opportunity to use the waters of this river would be particularly attractive if the flow could be augmented by discharge from the Ilopango Lagoon. Theoretical calculations indicate that with a maximum fluctuation in level of 1 meter plus an allowance for evaporation, Ilopango Lagoon could well serve as a storage basin with a minimum controlled discharge of 3 cu.m./sec. However, among other disadvantages, the quality of the water was questionable. It was recommended that a series of tests be performed for boron and sodium content before further action was undertaken on this proposal.

East and west of Río Jiboa area are 18 small, spring-fed streams which could serve as a source of irrigation water. However, their average individual minimum flows were less than 0.25 cu.m./sec. which rules them out for possible large-scale irrigation projects.

Improvement projects for Area II, not necessarily in the order of priority, were proposed as follows.

1. Drainage improvements and local irrigation from groundwater if feasible in the La Libertad-Río Comalapa region. Up to 3,000 hectares could be irrigated if water is available. Surface water sources are not favorable, so the only alternative is further study of the groundwater potential.

2. Any significant additional development in the Río Comalapa-Río Jiboa area will depend on irrigation. Land conditions between the 5-meter and the 30-meter contour are favorable; above the 30-meter elevation the topography is rough and would result in high costs, whereas below the 5-meter level drainage is a prerequisite. Of the 8,000 hectares

of potentially irrigable land, 75 percent could be irrigated by diversion from the Río Jiboa or from the groundwater. Large scale projects would require water storage; the Ilopango Lagoon is the only economical site available, and it is limited by a small collection area, evaporation problems, and water quality questions.

In 1953 the Comisión Ejecutiva Hidroeléctrica del Río Lempa developed an irrigation and drainage project for the area east of La Herradura and in the Río Jiboa-Rio Amate region. Water from a diversion dam on the Río Lempa would be used to irrigate 17,000 hectares of land west of the Río Lempa--3,000 hectares along the high ground of the Carretera Litoral, 7,000 west of the Río Amates, and 7,000 between the Río Amates and the Río Lempa. More than 80 percent of the lower 14,000 hectares would require extensive flood control and drainage. The irrigation costs were estimated at $1,200 per hectare for capital costs, and $90 per hectare annual operation and maintenance costs. The drainage costs were $360 per hectare capital cost, plus $37 per hectare annual costs.

Area III

Lands on both sides of the Río Lempa downstream from the dam at El Guayabo are included in this area. The major portion is included in the coastal plain area, which extends from the Río Amates on the west to the Río La Poza on the east. The area of principal agricultural interest extends from about two km. upstream from San Marcos Lempa to about 20 km. downstream, practically to the mouth of the river. The potential irrigable area (below the Carretera Litoral) covers an expanse of about 38,400 hectares. The gross area is about 90,000 hectares, of which about one-third is swamp. From the dam to the Cuscatlán bridge, the river is confined to a narrow, rocky channel and the potential development area of 480 hectares is composed of scattered small pockets of alluvial soils.

The Río Lempa is practically the only source of surface water in the area, although the Río La Poza, which is the eastern boundary of the area, is used by Hacienda La Carrera for water supply and some irrigation. Springs from the Volcano Usulután are the principal source of water for both the Río La Poza and the Río Molina, although the flow in the latter stream is not sufficient to support any extensive irrigation works.

The Río Lempa, at the time of the report, was the only river in El Salvador with a continuous flow record of any consequence. The first station was established in 1942 at La Pintada, and a second station was established at Chorrera del Guayabo in 1951. The drainage area at this second station is 9,780 sq. km., and the minimum flow recorded during 1955-56 was 43 cu. m./sec., which could supply the irrigation requirements for 38,400 hectares.

In 1953 the Comisión Ejecutiva Hidroeléctrica del Río Lempa developed a combined drainage and irrigation project with a diversion dam located upstream from the Litoral bridge. The economic aspects of the proposal are shown in tables 4, 5 and 6.

An additional cost to the farmer would be $10 per hectare for secondary drainage facilities, and $10 per hectare for land leveling and a farm distribution system.

The net gain of $164 per hectare is based on full operation of the project. The net gain of $102 per hectare is acceptable for gravity drainage, but the net gain of $57 per hectare for pump drainage is a borderline case. If pump irrigation is eliminated, the increase in net income on the 28,000 hectares will be around $128 per hectare. The pumping systems net earnings of about $61 is probably not sufficient justification for this part of the project. All pumping systems should be delayed until all gravity systems have been completely developed.

The high investments required and other factors would indicate that the Río Lempa Project should not be installed as one large undertaking, but rather should be constructed in stages as conditions warrant. For instance, the proposed drainage plans, which must precede irrigation in any case, will improve the lands in the project area and bring on an increased income, even though it may be necessary to delay the irrigation plans for several years.

The actual crop production in the area was not ascertained during the study, but the following typical crops were assumed to be planted in the proportions indicated:

Crops	Percent	Hectares
Corn	35	13,400
Cotton	25	9,600
Rice	15	5,800
Beans	15	3,800
Pasture	10	3,800
	100	38,400

Table 7 shows the production that can be expected for 12 months of cultivation per year of the assumed crops. The values shown represent 1.75 times the capacity of land under good farming practices, but without irrigation; and about 2.5 times the production actually achieved under current farming practices.

Ultimately the national economy will demand the construction of the lower Lempa project, even if government subsidies are necessary. The deficit to be expected during the development period is unfavorable, however, and more modest projects in other areas should be given priority.

The drainage project is justified and should be initiated soon. A detailed groundwater survey should be completed before either drainage or irrigation plans are prepared in detail.

Area IV

The Rio San Miguel, in eastern El Salvador, drains about 10 percent of the country and is the largest drainage area contained completely within the country. The entire drainage area is 2,050 sq. km,. of which about 1,075 are below the city of San Miguel. The fan-like system of its tributaries, originating in the mountains and converging just above the city, encourages flood conditions. San Miguel volcano with its numerous springs contribute significantly to the San Miguel flow.

Downriver from San Miguel, the valley is one of the most important agricultural areas in the country. The area is subject to flooding many months out of the year because of the converging tributory system, the sudden low gradient of the river, and the river's meandering course.

All of the irrigable lands of any consequence lie downstream from the city, and may be divided into two principal areas. The first consists of 10,300 hectares between the Pan American Highway and Olomega Lagoon, and the second comprises 10,100 hectares located downstream from Olomega Lagoon and west of El Delirio. The latter includes El Jocotal Valley and the zone west of Puente Vado Marín. To irrigate the total area of 20,400 hectares, a flow of 20.4 cu.m./sec. is required.

There were no continuous flow readings available for the Rio San Miguel at the time of the study. The CNA (Centro Nacional de Agronomia) had made intermittent flow readings on both the San Miguel and the Rio San Antonio Silva, but they were not conclusive. Information available shows fluctuations in minimum flow of from 2.3 to 1.3 liters per second per square kilometer. There is a clear indication of the need for a storage basin to increase the minimum flow to the level required if water is to be made available to all irrigable lands. Water duty was based on the rule of thumb of 1,000 hectares irrigated by each 1.0 cu.m./sec. There are two storage areas available upriver from San Miguel and the Olomega Lagoon.

The possible storage areas upstream from San Miguel are limited both by size and by local geological conditions. The most favorable is on the Río Yamabol, about 9 km. northeast of San Miguel. With a storage capacity of 82,000,000 cu.m., the minimum flow could be increased to 10 cu.m./sec. at El Delirio, which is enough to irrigate 10,000 hectares.

Olomega Lagoon is not an efficient storage area because of its large size and small depth. The entrance and exit canals would have to have equal capacity, for the lagoon cannot be used both for flood control and storage. It would fill early in the rainy season, and then all subsequent flash floods must be able to both flow into and out of the lagoon without restriction. There are two alternative plans for converting the Olomega Lagoon into a storage basin. One plan is to construct a series of levees along the north and east sides, and the other is to use it in its natural condition.

Without levees there would be an unavoidable flooding of about 2,000 hectares. The levee system would require some 8 km. of levees. It has the disadvantage of raising the water table and inundating the lands on the low side. A system of pump drainage would be required, which would add to the cost. A useful storage of some 80 million cu. m. would require an investment of about $6 million, plus another $150,000 for channel improvements. Table 8 compares the two possibilities. Table 9 presents cost estimates for the irrigation system and table 10 compares the costs of alternative storage plans.

Near the city of San Miguel there are about 1,000 hectares that could be irrigated under individual development projects by pumping from groundwater. The Olomega drainage basin, once the soils have been improved by drainage, could be irrigated by groundwater pumping. This would be an excellent area for rice.

In all cases it is estimated that the direct benefit to the farmer is $180/hectare/year ($200/hectare minus $20/hectare farm improvements). Under these conditions, Plan A gives the best benefit ratio.

Table 12, which shows the annual production possibilities from 2,500 hectares (Plan A), is based on continuous land use throughout the year. The potential production illustrated is about 1.75 times the potential of the area without irrigation and about twice the actual production at the time of the study. Actual production is estimated at 80 percent of the potential production without irrigation.

The following are the recommedations presented for Area IV:

1. The construction of one or more storage dams on the Rio Grande de San Miguel to increase the volume available for irrigation; and/or

2. The development of the storage capacity of the Olomega Lagoon.

3. Rio Grande channel improvements and surface water diversion for irrigation in Jocotal Valley, possibly supplemented with pumping from groundwater.

4. Development of groundwater resources in Olomega Basin and Jocotal Valley to provide additional irrigation water.

Plan II (Olomega Lagoon storage without levees) is the most economical of all the storage dam proposals. This plan will inundate some 2,000 hectares surrounding the lagoon. Before a choice can be made between a dam system on the upper river and a dam system using the Olomega Lagoon for storage, careful studies will be required, including topography, geology, river gauging, and groundwater studies.

Area V

Area V, which includes the 3.5 sq. km. drainage basin of the Rio Sirama (or Rio Bolívar), is bounded on the west by the Rio Grande de San Miguel basin, on the east and north by the basin of the Rio Guascoran, and on the south by La Unión Bay. It is composed of three principal tributaries--Rio Grande de Bolívar to the north, Rio Tizate in the middle, and Rio Paso de Conchagua (or Rio San Alejo) to the south. The three converge just upstream from the bridge on the road between Pasaquina and La Unión. Most of the basin is broken, hilly, and rolling, with pasture lands the principal agricultural activity except for small cultivation scattered along the stream banks.

There are no existing flow records of the Rio Sirama, although the flow has been estimated to vary from 0.5 cu.m./sec. minimum flow to 500 cu. m./sec. flood flow. The soils of the region in general are not adaptable to intensive cultivation. The level lands near the Bay are saline and would require complete and expensive recovery projects.

Because of the poor conditions of topography, soil, and saline conditions, no project can be recommended. Individual irrigation installations on the isolated small alluvial soil pockets could be profitable.

Area VI

The drainage basin of the Rio Sucio covers an area of about 800 sq. km. and is bounded on the east by San Salvador Volcano, on the west by

Izalco Volcano and Lake Coatepeque, on the south by a chain of rugged hills, and on the north by other rugged hills and rolling land. The Río Sucio is a tributary of the upper Lempa. About 80 percent of the basin is above the Quezaltepeque Power Plant.

The agricultural areas of any importance are the Zapotitán Basin (about 3,500 hectares between Hacienda Zapotitán and Ateos), the San Andrés Valley (about 1,200 hectares of gently rolling land between Santa Tecla and Santa Ana), and some parts of the Río Sucio Valley between Sitio del Niño and the Río Lempa. Except for the El Jocote Valley, the lower Río Sucio does not offer much potential. At the junction of the Ríos Suquiapa, Sucio, and Lempa, there is a relatively flat area of about 1,000 hectares, and in the El Jocote Valley the flat terrain covers an area of some 1,500 hectares.

At the time of the report the Zapotitán swamp was covered by woodland, but it could be used for pastures in the dry season. Both private and government drainage works have reclaimed large areas in the Zapotitán and San Andrés areas, most of which has been planted to corn. There are still some 700 hectares that are too wet for any type of cultivation and another 1,000 hectares that could be improved by drainage. The San Andrés Valley is planted principally to sugar cane, while the El Jocote Valley is cotton and irrigated pastures.

As far as minimum flow is concerned, the Río Sucio is one of the most dependable in the country. The headwater area is surrounded by volcanoes that supply a constant source of spring water. The Río Sucio has been measured for minimum flow at the Quezaltepeque hydroelectric power plant since 1945. The drainage area at this point is 670 sq. km., and a minimum flow of the Río Sucio is from springs and not from the Zapotitán swamp, it is felt that this swamp could be safely drained without adversely affecting the flow of the river.

In 1947 the CNA proposed a multiple-purpose development of the Zapotitán area, which included the irrigation of some 2,800 hectares. The plan, which included a storage dam in the western part of the Zapotitán Basin, was not considered feasible, principally because the minimum flow does not supply sufficient water for both hydropower requirements and irrigation.

A reclamation plan for the Zapotitan swamp area was proposed as an alternate and much more feasible project. This plan, which recommended that irrigation from pumping groundwater rather than by diversion from the streams, included the following:

1. Channel improvement for the Ríos Chuchucate and Colón for 7,700 meters.

2. New channel for Río Talnique for 5,500 meters.

3. Channel improvement for Río Copapayo for 3,000 meters. This corrected channel would parallel Ríos Talnique and Chuchucate.

4. A complete drainage system for 1,700 hectares.

5. A system of small drainage structures to insure access to recovered land.

This work would bring into production about 700 hectares of previously useless land, and would double the production of another 1,000 hectares of land now under cultivation but poorly drained. Increase in annual income was estimated as follows:

700 hectares of new land at $270	$189,000
1,000 hectares of improved land at $135	135,000
	$324,000
Average/hectare	190
Net average gain to landowners ($190 - $27.60)	$162/hectares

It was concluded that the Zapotitán Reclamation Project was the only project that could be justified for government participation in Area VI, justifiable with or without irrigation. It was recommended that detailed studies should be undertaken at once. Irrigation from the Río Sucio could conceivably lower power development potential at El Guayabo. This required further study. Pumping groundwater in Zapotitán could serve the double purpose of supplying irrigation water and of lowering the water table. Further study is required on this important aspect.

Recommended National Investigation Program

General

If the maximum potential of lands and water is to be realized, the GOES must formulate a convenient national policy with respect to these two national resources. Once national policy is established, existing legislation should be studied and reinforced where necessary to assure the realization of the desired results. An important factor is a water rights law. The law should cover the use and control of both surface and groundwater. Supplementary laws to stimulate the private initiation of hydraulic projects (subsidies, direct financial assistance, easy credit, tax concessions) should be enacted.

Both short and long-term planning is required, and institutions should be consolidated or created to efficiently handle the planning and execution of hydraulic projects. However, planning demands that basic data be available as needed. Certain data collection programs should be initiated immediately. This would include topographic mapping at 1:50,000 scale (now complete for all practical purposes, and revised sheets are being prepared of the coastal plain areas) and 1:10,000 scale for all proposed project areas.

A greatly expanded program of stream gauging was also recommended. Continuous recording devices such as those developed by the Water Resources Branch, U.S. Geological Survey, were recommended for installation in 31 specific locations throughout the nation. The installation cost of such a project was estimated at $50,000, and the annual costs were estimated at $30,000.

The installation of two additional evaporation stations was also recommended. The estimated installation cost of two Class A U.S. Weather Bureau Stations was estimated at $500, and the annual operating costs at $1,000.

The need for a nationwide groundwater study was emphasized, and it was recommended that five exploratory wells be installed in each zone, except for Zone No. 5. Drilling logs would be carefully kept, which would be of sufficient depth to penetrate all important aquifers. Test pumping would be conducted on at least one well in each zone, and key wells would be selected for permanent observation. Especially in the irrigated areas, but elsewhere as indicated, additional wells should be drilled so that the groundwater fluctuations of the individual basins might be determined.

Based on a drilling cost of $25 per meter and $10,000 for one portable pump and motor, it was estimated that the total cost of the groundwater investigation program would be $80,000. Some $30,000 of this sum would be for drilling costs, and the balance of $50,000 would be for pumping tests. The annual costs thereafter for observation of groundwater would be about $2,000.

Conclusions

1. The quantity of water that can be used for irrigation is limited by the physical and climatic characteristics of El Salvador. The extent to which irrigation may be used to increase agricultural production will be determined more by the availability of water than by the amount of irrigable lands.

2. Irrigation can be used to increase production practically anywhere in El Salvador where water is available and topography is satisfactory. Soils will rarely be a limiting factor as long as appropriate programs of irrigation, fertilization, crop selection, and land management are observed.

3. Any large-scale use of surface water for irrigation in El Salvador will require the previous construction of storage dams. The topography and geology of the country are such that dams of this nature will be expensive and almost prohibitively uneconomical at the present time. However, water supplies will become of increasing importance, and someday the dams will be justifiable. Thus all possible storage sites should be carefully investigated now.

4. With presently available information it is impossible to estimate the extent to which groundwater may be used for irrigation. An exploratory well program should be initiated at once on a national scale.

5. Many small, surface water sources which could be developed by individual farmers go unused. If irrigation is to be stimulated, the use of local supplies by the farmers should be encouraged.

6. Increased use of the land made possible by irrigation will produce sufficient additional income during a 12-month period to pay all the annual costs of irrigation, and still leave a good income for the owners for all crops, except perhaps for pasture. In the latter case, the cost should not exceed $0.0056/cu.m.; and for pasture devoted to dairy herds, should not exceed $0.004/cu.m.

7. Drainage of all areas, except those covered by sea water, and flood protection measures offer a practical means of increasing the productive area of the nation.

8. Capital investments to recover nonproductive lands by adequate drainage could be at least equal to the normal value of an equivalent area of productive lands. In such cases, the value of the land rental of the recovered lands by itself would be sufficient to cover the annual costs of a reclamation project.

9. The production capacity of agricultural land in El Salvador is very high in those areas where appropriate agricultural practices are employed. Land recovered by drainage and flood control and land on which irrigation is applied will produce returns equal to the best of other parts of the world as long as climatically adaptable crops are used in the region.

10. There are no major economic problems with respect to urban flooding that justify the expenditure of large sums of money in the areas studied. However, there are some local flooding problems that could become economically important with future growth of the cities involved.

11. Completion of the Carretera Litoral and normal economic pressure will stimulate the expansion of agriculture in the coastal area, but the improvements of major importance with respect to drainage, flood control, and irrigation will require some form of governmental assistance. The large projects, such as irrigation on the Lower Rio Lempa, will require not only direct help from the government, but financial subsidies during the first years of construction.

12. There is an adequate margin in the feasibility calculation to cover any forseen variations in the preliminary cost estimates of the projects and those that might arise during final design. Ample figures were used to compute costs and modest figures to calculate the probable increase in production that would result from each project.

Recommendations

1. Initiate immediately a program of compiling information that includes the mapping, stream gauging, water quality analysis, evaporation stations, and groundwater studies.

2. The projects listed in table 14 should be initiated in the order in which they appear in the table.

3. Existing national policies, water laws, and other legislation should be reviewed to determine if additional policies should be adopted or additional legislation promulgated, to promote the orderly development of land and water resources of the nation and to protect the proposed projects once they have been completed.

ZAPOTITAN PROJECT

Project for the Agricultural Development of Zapotitán Valley

Grontmij, De Bilt, Holland,
June 21, 1961

This study was initiated as a direct result of one of the recommendations advanced by the TAMS Report. The 3,500 hectare-area included in the study was bounded by the Santa Tecla-Armenia Road, the Rio Copapayo and the Zapotitán swamp, the Rio Sucio, and the Inter-American Highway. The study was later extended to include the Zapotitán swamp, giving a final project area of 4,600 hectares.

The objectives of the study were to improve agricultural conditions in the Zapotitán Valley and to create a pilot project which might serve as an example for similar developments throughout the rest of the country. Although irrigation, drainage, and flood control works were to cover the entire valley, it was decided that water deliveries and drainage outlets would be provided only to land units of 80 hectares or less in size.

The Zapotitán Valley is of complex geological origin. The original drainage to the west was blocked by volcanic action, and when the alternate outlet to the southwest was also blocked, a lake was formed. The elevation of the lake gradually rose until an outlet to the northwest was formed, thus creating the Rio Sucio. From that time the Rio Sucio has gradually drained the lake, and as the coastline receded, sediments of varied origin filled the lake site. At present the alluvial sediments are estimated to be more than 200 feet deep.

With the exception of some minor stream course improvements made in 1956, no drainage or stream adjustments have been attempted in this area. Private property owners have been discouraged in their drainage activities by the provision of the law that prohibits the discharge of drainage water on lower property except through a natural water course. The lack of a state institution legally constituted to take care of drainage problems further complicates the matter.

Private landowners do practice a certain amount of irrigation by damming the streams at the beginning of the dry season and diverting the flow through a series of crude ditches. The Civil Code states that the water rights are the property of the landowner through which the stream passes, but no attempt is made to limit the maximum amount that may be withdrawn without being prejudicial to the downstream landowners.

The municipalities are responsible for limiting total diversion, and where the stream crosses two or more municipalities, a common agreement must be negotiated. However, this is very difficult to administer and very few municipalities have even undertaken such control measures. Ciudad Arce has designated a water judge to control the dry season flow of the Río Chuchucate, but the judge's authority is limited. The water charge of ₡5 per manzana in 1959-60 was applied to a total of 510 hectares out of 730 in irrigation. A total of 102 persons requested release of water, but only 26 paid the charge.

In the area under irrigation, the soils are highly permeable, the water table is high, and the main canals are unlined. Thus, the custom is to request water and then never directly apply it to the land. The high seepage losses from the main canal accomplish a quite efficient type of subsurface irrigation, and no water is ever legally diverted. Estimates of water consumption varied from 2.3 to 0.9 liters/second/hectare. The higher consumption was in the uplands where the soil is more permeable and large landowners predominate. (This group has a tendency to waste water.) No estimates were given concerning frequency of application.

The meteorological data for this project came from San Andrés station, which has been operating since 1948. However, long-term projections were based on the 40-year records from San Salvador. Because of the favorable climatic conditions that prevail, a great variety of crops may be grown, both coastal plain and mountain types.

Evapotranspiration was computed by the Penman Method for the six-year period 1954-59, and was found to fluctuate between a minimum 442 mm. and a maximum 672 mm. annually, with an average of 533 mm. Evapotranspiration accounts for about 70 percent of the total precipitation.

Calculations indicate that 3 mm./day would be sufficient to cover the water deficit of the plants during the dry season. At that daily consumption rate, the available soil moisture is sufficient to provide the basic moisture necessities for 20 to 30 days during the dry season. At the end of the dry season, 70 percent of the land has a sufficiently high water table to supply water through capillary water. In the balance the water table is sufficiently low that some type of irrigation must be practiced. The Río Sucio depends on the inflow of underground water to retain a minimum flow during the dry season, and this stage is reached as quickly as the precipitation level lowers to a point equal to or less than the evapotranspiration. The minimum flow, which reflects groundwater runoff, varies from 2.65 to 3.0 cu. m./second, averaging 2.7 cu. m./second.

For the purpose of classifying present cultural practices, the area was divided into four zones:

I - 2,874 manzanas: Low area; principal crop is rice.
II - 1,317 manzanas: Very low area, unfit for intensive cultivation; mostly in pastures and rice.
III - 1,004 manzanas: Composed of large farms; principal activity is livestock.
IV - 1,001 manzanas: Similar to Zone III, but needs irrigation during the dry season.

Farm labor requirements were estimated at 3.1 manzanas per man-year for a combination dairy and grain operation, and 5.1 manzanas per man-year for a livestock and cereals operation. With an area average of one man per 4 manzanas, some 1,600 rural laborers would be required to manage the 6,500 manzanas contemplated for the project.

The price of rural land at the time of the study varied from ¢2000 to ¢800 per manzana in Zone I, and averaged ¢1,200 per manzana in Zone II, and ¢2,500 per manzana in Zones III and IV. The average for the entire project area was about ¢1,300 per manzana.

Flood control measures are an essential condition for other proposed improvements, but since complete and total flood control is impractical, the proposed improvements are based on maximum normal flood conditions. The measures recommended were channel improvement and levee construction, but since any change in a river regime will provoke changes both upstream and downstream from the site, it was also recommended that a continuous study of the reaction of the river to the new conditions be maintained.

The irrigation system was planned so that project water deliveries would be limited to units of about 80 hectares, and it would be delivered day and night on a rotation basis. Quantities delivered would be determined by crops cultivated and area planted, and would not be measured or charged for by volume. This particular system was adopted because farmers in the lower areas of the system can benefit from excess water delivered to the upper areas, and there is no way of measuring or charging for this excess water. Delivery will be from surface diversion and application methods. The project could be extended by the addition of ground water pumping in some of the areas inaccessible to surface water diversion canals. The proposed sources of water for this project are shown in table 20. To the total area irrigated by surface water diversion, 270 hectares must be added for swamp and 1100 hectares for possible irrigation by pumping, which gives a total project area of 4589 hectares.

The drainage system was designed to serve three principal functions: (1) to handle surface water runoff from rainfall, (2) to drain shallow ground-

water table, and (3) to drain away irrigation losses, infiltration, and waste water. Since intense rainfalls are expected, the capacity of the system will normally be placed at the quantity of surface runoff expected under the following conditions:

1. Irrigation losses are light and occur only during the dry season.
2. Ground water movement is slow.
3. Surface runoff depends upon:
   a. Rainfall
   b. Velocity of infiltration and moisture holding capacity of the soils.

The labor demand for various agricultural activities as outlined in table 17 was used in computing the production possibilities for a hypothetical 5-manzana family farm, which was the size selected as optimum for exploiting the ICR lands within the project area. It was assumed that a typical rural family consisted of 5.2 persons, and that 35 percent of the family was economically active.

The following tables present the data from which it was concluded that the Zapotitan project is feasible and should have a high order of priority.

Table 18 shows that with a total net income of ₡7,194,000, the average is ₡5,900 per parcel, or ₡1,180 per manzana. If land rental, amortization charges, and other obligations total ₡2,000, the net return per land parcel is about ₡4,000, which is very favorable when compared with the annual net return realized by farm laborers.

Table 19 shows the estimated income of the project area without irrigation and drainage. If the income figure of ₡410 per manzana is reduced by 7 percent, (to correspond to the percentage of the gross area of the project in roads, ditches, laterals, etc.), the balance is ₡380 per manzana. The increase in income due to improvements is ₡1,180 minus ₡380, or ₡800 per manzana.

To facilitate the handling of administrative and infrastructure problems, it was proposed that the project be designated a "Special Development Area" so that necessary administrative measures could be lawfully adopted. A complete organization under MAG was proposed, including a conservation and irrigation district, credit facilities, and extension services (including experimental farms). It was especially emphasized that credit should be kept out of the hands of commercial banks and that responsibility for credit supervision be placed in an agricultural organization.

Tables 20 and 21 show the credit requirements and amortization plan for the farm units, and tables 22-26 show the total investment and public investment required.

It was recommended that the state assume the responsibility for the costs of flood control, roads, land reclamation. Irrigation and drainage costs should be the responsibility of the landowner.

The conclusion was that the project is economically feasible and will make an important contribution to the national economy.

A five-year development plan was recommended with the order or priority of the work as follows:

1. Roads
2. Flood control
3. Drainage
4. Irrigation
5. Land reclamation

After the Grontmij report had been accepted by the GOES and studied by all concerned, an attempt was made to obtain a loan from an international agency to finance the construction of this project. The Inter-American Development Bank (IDB) offered to finance the project, and a formal loan agreement was drawn up between the two interested parties. However, when the loan documents were presented to the National Assembly for ratification, the loan was rejected on the grounds that the terms were not in the best interests of the nation.

Negotiations were then undertaken with USAID for a loan from that organization, and in November 1964, the GOES submitted a formal loan application for $1.7 million to finance the development costs of a 4,600-hectare project in Zapotitán. The supporting data submitted in that application were based directly on the Grontmij report. However, the time schedule was changed from five to three years. The subsidy schedule proposed by GOES is shown in table 26.

IAGS/NRD Critique of Grontmij Study

USAID, upon receipt of the formal loan application from GOES, sought technical advice from the Natural Resources Section of the Inter-American Geodetic Survey located in the Canal Zone. This agency reviewed all documentation of the project, and in December 1964 a preliminary report was submitted to USAID. The principal criticisms were directed at such technical factors as levee side slopes, hydraulic gradients in drainage ditches, and maximum ditch capacity.

The minimum water requirements were also questioned. The report recommended a flow 700 liters/sec. to irrigate 4,600 hectares,

which is equivalent to 0.15 liters/sec./hectare. In view of the fact that current water use in Zapotitán varied from 0.8 to 2.3 liters/sec./hectare, IAGS/NRD recommended a minimum average of 0.5 liters/sec./hectare.

It should be noted that the IAGS/NRD review also emphasized that technical feasibility does not necessarily guarantee success. Human factors both at the management level and at the farm level are of prime importance. Any program of this magnitude should also include provisions for adequate extension and credit facilities, and should not be undertaken until authority exists for the establishment of an irrigation district or other semiautonomous agency to manage the project until the beneficiaries are ready to assume the responsibility themselves.

In 1965 the final IAGS/NRD report was submitted to USAID. There were no major changes from the preliminary document, except that a great deal of supporting documentation was included. Cost estimates were adjusted upwards to reflect the unit prices existing in El Salvador in 1965, and small amounts were added for miscellaneous and contingency items (table 27). The annual production costs and benefits were also recalculated (table 28).

It was recommended that a consulting firm be retained to prepare the final project designs and supervise construction. Harza Engineering International was subsequently selected for final project design, but a firm from Israel (TAHAL Consulting Engineers) was selected to supervise project construction and prepare an overall agricultural development plan.

ZAPOTITAN VALLEY

Feasibility Report, Agricultural Development of the Zapotitán Valley

Harza Engineering International and A. Garcia Prieto, March 1966

This report was prepared as a direct result of the recommendations of the IAGS/NRD advisory team. The gross area of the project was 4,780 hectares and the net was 4,320 hectares. A conservative estimate was made of the benefits to be expected, based on all water being supplied by groundwater pumping. The average farm size was taken to be 5 hectares.

Geologic interpretations indicated that annual recharge of the groundwater basin was more than adequate to meet the water needs of the entire project; hence, the decision to switch from surface water diversion to groundwater pumping because of the greater reliability of the latter source. The well spacing proposed for this project was based on one well for each 40 hectares. The cost estimates were on the basis of 35 liters/sec. pumped against a 60-meter lift. Electric power was selected as being the more economical and the maximum demand was calculated to be 2,500 KW with an average annual total use of 7.3 million KWH. The delivery rate to the farm was calculated at 0.75 liters/sec./hectare, with a total water delivery of 7,300 cu. m./hectare.

It was recommended that the development be carried forward in two stages: I. Flood control, primary drainage, and roads; and II. irrigation and secondary drainage. Table 29 shows the total project investment by stages.

Six land classes were established according to the USBR system of land classification. Table 30 shows the extent of each class and the changes expected from the drainage and reclamation efforts proposed for the project. Tables 31-33 show the expected increases in production.

It was estimated that of the average five members of a rural family, 1.8 would contribute full-time labor. It was further assumed that the head of the family would labor 300 man-days per year and the other family members would labor a total of 250 man-days per year. For budgeting purposes, it was assumed that the daily rate for farm labor would be ¢2.50. On the basis of the assumptions made, the annual income from a 5-hectare land unit would be about ¢4,824, the family living allowance ¢2,485, the payment capacity increased by ¢2,211 (tables 34 and 35).

The report points out there are three sources of credit available to the average farmer in this project: (1) The Program for the Improvement of Agricultural Lands (META) uses funds obtained from a loan negotiated with USAID. This results in an unsatisfactory procedure, since the farmer must make the loan with a commercial bank (on commercial terms), and this bank in turn discounts the loan with project funds on deposit in the Central Bank. (2) The Administration for Rural Welfare (ABC) is also an AID-financed program. (Funds generated by the sale of wheat under Title IV, P.L. 480.) It is limited to small farmers (those holding 20 hectares or less) and an interest rate of 8 percent. Production loans must be repaid from the current crop, but improvement loans may be negotiated up to a maximum period of seven years. (3) Straight commercial loans are the least desirable of all for the small or medium-sized farmer because of the collateral demanded.

After the basic Harza report had been received and studied by all concerned, it was mutually decided that a project that depended exclusively upon groundwater pumping for its source of water supply would be too expensive and would not make full use of all the available water resources. Harza was therefore asked to revise the proposed plan and change it to an integrated surface-groundwater system. The revised report was submitted in July 1966.

The combination system that was proposed, and which is essentially the system that is now being installed, included a total irrigated area of 4,230 hectares, of which 2,090 hectares would be irrigated by surface water diversion and 2,140 hectares by groundwater pumping. Total surface flow would be diverted during the dry season, and the lands irrigated by such water would coincide almost entirely with those that were already under some type of irrigation system. The average water requirement for all cases was set at 0.70 liters/sec./hectare, which takes into account delivery losses and peak demand consumptive use.

For the surface water diversion system, water would be taken by gravity from all rivers concerned except for the Belén and Los Patos rivers, which would require pump diversion. Water delivery in the surface water system would be on a rotational basis, whereas the groundwater pumping system would be on a demand basis.

For the groundwater pumping system it was estimated that a total of 48 wells would be required, or an average of one well for every 30 to 60 hectares. Pumping requirements would vary from 450 to 720 gpm. depending upon the size of the area to be irrigated from the individual wells. However, costs were calculated on the basis of 50 wells and 52 sets of pumps and motors. Even though the calculated hydrologic budget indicated that total precipitation infiltration would balance the discharge

from the basin with the number of wells indicated, it was recommended that a thorough hydrologic budget study be initiated and continued over a period of several years to definitely determine the maximum recharge possibilities of the basin. The revised cost estimates and benefit-cost ratios are shown in tables 36 and 37.

Even though water quality tests divulged a slight salinity problem, it was felt that the high leaching action expected during the rainy season would prevent a salt buildup. However, frequent testing was recommended to be sure that the boron content does not materially increase with the volume of pumping contemplated.

The Zapotitán project is now underway as an integrated surface water-groundwater irrigation project in essentially the form proposed in the revised Harza report. It is being financed by national funds. The principal reason for this decision was the reluctance of international financing agencies to fund the project until the necessary national water policy legislation had been enacted by Congress.

Publicly owned land is being subdivided into family-size land units. The criteria used to determine the size of such units included:

1. Family-size land units should produce an income (monetary or in kind) equal to that earned by a laborer under the minimum wage law.
2. It should produce an income equal to the national per capita income.
3. It should provide full-time occupation to the head of the family, taking into account seasonal underemployment, and provide part-time work for the rest of the family.

Estimates concerning the size of land unit that will satisfy this definition in the Zapotitán area varied from 1 to 5 hectares. It was recommended that the average size be set at a total of 3 manzanas (a little over 2 hectares), composed of 2.5 manzanas of project land for exploitation, and 0.5 manzanas of nonagricultural land for the home and for the care of subsistence livestock (chickens, swine, a cow, etc.).

A medium-sized land unit in the project area was defined as 30 manzanas, the minimum size that would produce an annual net income of ¢15,000.

RIO GRANDE DE SAN MIGUEL BASIN

Groundwater Research Project, Lower Basin of the Rio Grande de San Miguel, El Salvador, General Report, UNSF/FAO, 1964

As a direct result of one of the recommendations of the TAMS report, GOES and the UNSF entered into a project agreement in May 1960 for a groundwater exploration project in the lower basin area of the Rio Grande de San Miguel. The project consisted of three phases:

Phase I. Geological and hydrogeological studies.
Phase II. Engineering studies and well drilling and testing.
Phase III. Preparation of a development plan for 10,000 hectares. (Results of the first two phases indicated that the basin had sufficient recharge potential to justify an irrigation development for an area of this size.)

At the completion of the first two phases, a development plan for the exploitation of the groundwater potential was presented, consisting of:

- Development of a groundwater project to irrigate 10,000 hectares.
- Establishment of an irrigation demonstration farm. (The well was drilled at the indicated location and the pump and motor were installed, but the demonstration farm never advanced beyond this stage.)
- Establishment of a national water policy and the enactment of proper legislation to initiate and maintain such a policy.
- Production well drilling program. Development of 170 wells to irrigate 10,000 hectares.

The Rio Grande de San Miguel Basin, with about 35 percent of all farms included within its scope, is one of the country's most important agricultural areas. About 68 percent of the nation's cotton, 32 percent of the corn, and 23 percent of the coffee are produced here.

The area is also one of the nation's more important areas of potential expansion of agricultural production. It was once estimated that land reclamation and improved cultivation practices could increase production tenfold in the region.

Table 38 shows the water budget for the San Miguel Basin in 1962. Runoff for the basin in the 1962 climatic year was 698 million cubic meters, of which 86 percent was groundwater and 14 percent was storm runoff. Available data indicate that only about 10 percent of the precipitation that falls in the basin and is available for recharging purposes is actually used.

In the development of project cost estimates, drilling costs (table 39), pumping costs (table 40), and lists of lining canals (table 41), were evaluated. Tables 42 and 43 show other cost evaluations, and table 44 summarizes all these.

The following considerations governed the cost estimates for producing wells:

1. Uneconomical to pump from depths in excess of 250 feet.
2. Gravel costs - $10/c.m.
3. Pumping plant - $7,650 for electric, $8,800 for diesel.
4. Casing costs (12" to 14") - Blank - $6 to $7/ft.
   Perforated - $7 to $8/ft.

RIO GRANDE DE SAN MIGUEL BASIN

Appraisal Report, Harza Engineering Co. International and A. García Prieto, April 1966

Following one of the recommendations of the TAMS report and further urged on by the results of the UNSF groundwater investigation of the Lower Basin of the Río Grande de San Miguel, the GOES entered into a contract with Harza and Garcia to appraise the irrigation, drainage, and flood control needs of the entire Rio San Miguel Basin. The preliminary recommendations advanced were for the development of the basin in three distinct stages:

I. Flood control and drainage of 20,000 hectares.
II. Irrigation of 26,000 hectares:
   a. 16,000 by surface diversion.
   b. 10,000 by groundwater pumping.
III. Hydroelectric development.

One of the first steps taken in this study was the preparation of a land classification map of the entire project area. The system, which was based on USSCS standards, was oriented towards reclamation and agricultural production according to the following scheme:

1. Lands with little or no drainage problems (1, 2s, 2t, 2st, 2sd, 3st).
2. Imperfectly drained lands but with a potential classification of 2sd with project drainage and flood control.
3. Poorly drained lands, but with a potential classification of 3sd, 4sd, 4Pstd, and 4R with drainage and flood control.

A resume of this land classification system is shown in table 45. Table 48 shows the potential changes which can result from the proposed reclamation works. The principal crops of the area are shown by land classes in table 46, and crop yields, by land classes, are shown in table 47. Tables 49 and 50 show the proposed land uses according to the improvements proposed for the area, and tables 51, 52, and 53 show the corresponding expected production.

Several distinct possibilities for the development of the area were considered, all having a common purpose of achieving flood control and drainage on a minimum of 20,000 hectares in the Olomega, Jocotal, and Dionisio areas. These lands, which are now virtually unusable during the wet season, could be brought into cultivation with adequate drainage. Table 54 shows a comparison of all possible alternative plans. Tables 55-62 summarize costs and benefits. In essence, the recommended plan would irrigate 9,000 hectares in the Olomega area by pumping from storage, 5,000 hectares in the Jocotal area by gravity diversion and pumping, and 2,000 hectares in the San Dionisio area by gravity diversion.

An additional area of 10,000 hectares in the Usulután-Vado Marin area would be irrigated by pumping from groundwater. The groundwater development would include about 170 wells, each serving about 75 hectares. The wells would average 100 meters in depth and would pump from an average depth of 35 meters with power supplied by 35 HP motor.

With the provision of adequate drainage and flood protection, the present total production could be increased four times. With the addition of irrigation, an increase of at least six times that of the present production could be expected. Benefits from irrigation would be marginal for cotton, principally because no double cropping was anticipated. Rice, vegetables, beans, and corn could all benefit materially because two crops per year could be expected. Sugar cane would also benefit from applications of irrigation water during the February-April period.

Taking into account an expected farm application efficiency of 60 percent, conveyance, and other losses, the diversion requirements were set at 1cu.m./sec./1,000 hectares.

It was noted that before any of the projects can be initiated, certain additional data must be collected. Top priority in this case was assigned to the feasibility study of the Olomega Project. The Jocotal-San Dionisio feasibility study could be conducted concurrently with the Olomega Project, but should not precede it. Flood control and drainage aspects of the Usulután-Vado Marin Project would be the next in priority. The development of the pump-well irrigation project could be carried on concurrently with any of the previous studies, either on a project basis or on the basis of individual farm development. In any case, the continuation of the groundwater studies as well as the stream gauging activities and erosion control studies were strongly recommended.

UPPER RIO LEMPA BASIN

Reconnaissance Appraisal of Potential Agricultural Development of Upper Río Lempa Basin, Harza Engineering Co., International, and A. Garcia Prieto, May 1966

This report was initiated as a result of one of the recommendations made in the TAMS Report. The Upper Lempa Basin is located approximately 45 Km. north of San Salvador. The area studied extends from the proposed site of the Silencio hydroelectric project to the Astillero dam site. Elevation of the arable lands varies from 220 to 370 meters above sea level. Within the area are 23,000 hectares of potentially irrigable land, of which about 16,000 are presently in some type of cultivation. Most of the lands suitable for agricultural development are located on the north side of the Río Lempa and in the Department of Chalatenango. Table 63 shows the general distribution or arable land within the project area.

Rainfall during the rainy season is usually sufficient to meet the water needs of practically all crops. However, irrigation is essential for crop production during the dry period from November to March. The area also suffers from the lack of proper drainage during the rainy season, at which time the water table approaches the surface of the ground on about 75 percent of the potentially irrigable land.

The minimum flow of 18 cu.m./sec. on the Rio Lempa in this area is sufficient to irrigate 18,000 hectares without any storage. However, more and continuous stream recordings are required of all the tributaries before a final master irrigation plan can be developed. This is especially true of the tributaries entering from the north. Groundwater investigations of the entire area are also needed.

A land classification scheme was developed for the area:

I. Suitable for any intensive cultivation as long as drainage is adequate.
II. Suitable for any intensive cultivation with careful land management procedures.
III. Restricted development potential primarily due to the physical characteristics of the soil.
IV. Generally not suitable for intensive cultivation because of slopes and stoniness. Those lands presently in cultivation are seriously eroded.

Table 64 shows the distribution of land among the four classes.

Table 65 shows a tentatively recommended development scheme for the area. The diversion point for gravity application of water would be at about elevation 295 m. Detailed studies would be required to indicate the best location for pumping from streams and/or canals. The extent of groundwater pumping would be dependent upon the results obtained from detailed groundwater studies.

It should be noted that the realization of any additional hydroelectric power projects on the Rio Lempa could cause the inundation of about 5,000 hectares of potentially irrigable land. A thorough integration of both proposed uses of the waters of the Rio Lempa is important if optimum use is to be obtained from this area.

A two-phase study program for a more detailed development plan was presented:

1. An appraisal study to select priority projects.
2. A feasibility study of the selected project.

The first phase would be further subdivided into two subphases:

A. Collect basic data.
B. Select most feasible site for stage 2.

Phase 1A would include:

1. Soil survey.
2. Pilot farms (land capability Group III).
3. Hydrology (surface water).
4. Groundwater resources.
5. Water quality.

Phase 2A would include:

1. Geology, soil, and foundation material.
2. Topography and aerial photogrammetry.
3. Electric power.
4. Roads.
5. Soil conservation.
6. Drainage.
7. Groundwater investigation.
8. Alternative schemes.
9. Economic statistics.
10. Legal entity.

Tables 66-71 provide data on land use, costs, and benefits.

LA CABAÑA, S.A.,

Preliminary Irrigation Study, A. García Prieto
September 1965

La Cabaña is a sugar cane farm of 1,861 hectares located near the village of Paisnal in the Department of San Salvador. It is spread over the drainage area of two small streams the Rio Amayo and the Río Matigate, both tributaries of the Río Lempa. The land begins 2 km. north of Aguilares and continues north for 8 km. to the Río Lempa. The width east and west varies from 1-1/2 to 2-1/2 km. The topography is flat with natural drainage to the Lempa. The average elevation is 272 m. above sea level.

A detailed soil survey was performed in the area, including tests for permeability, infiltration, and water retention. The meteorological conditions established for Zapotitán were assumed to be the same for La Cabaña. Some adjustments were made where indicated so that the evapotranspiration could be more accurately established for the project. Water requirements were calculated by the Blaney Criddle Method.

Considering only the irrigation possibilities, it was estimated that 91 percent of the land in the project was irrigable and that the available water was adequate for that purpose. However, poor drainage is a disadvantage of the area. From July through September the water table is very high.

Although sugar cane is by far the dominant crop in the area, all other types of intensive cultivation have been tried at one time or another. It is apparent that the lack of adequate drainage and the lack of irrigation are the limiting factors in increasing agricultural production in the area to any extent.

Under the system used by the USBR to evaluate a farm for its repayment possibilities, there are six classifications: No. 1 is completely and easily repayable and No. 6 is incapable of ever repaying. La Cabaña is considered as being in the No. 2 Class. All of the irrigable soils could be watered by either direct diversion from surface water or by pumping from deep wells. However, only about 25 percent of these irrigable soils have adequate drainage. It was also established that one of the limiting factors in the increase in production in the area is that the maximum charge for operation and maintenance must not exceed $15 per ton.

A system of pumping with electric power from the Río Lempa and with gravity delivery to the fields was estimated to cost about ¢1,390,100, or ¢923 per irrigable hectare. A system of pumping from deep wells with electric power would consist of either 99 wells of 180 gal./min. each, or 33 wells of 540 gal./min. each. At a basic electric power rate of ¢0.07/KWH, the pumping cost of the large wells would be ¢1,400 per day, and the pumping cost of the small wells would be ¢596 per day. Gravel packed wells of 12-in. diameter were estimated to cost ¢150/lin.m., whereas those of 8-in. diameter were estimated at ¢100/lin.m. Table 73 shows that pumping from groundwater in addition to being more flexible is cheaper in original cost than the cost of pumping from the river.

In the final analysis, a combination system was selected. This system consists of 87 small wells and two diversion pumps on the Río Lempa. The total cost of this system was estimated at ¢791,460, or about ¢610 per hectare. The economic study for this system is shown in table 74 .

APPENDIX TO CHAPTER V

THE OPERATING UNIT IN AGRICULTURE

THE CLASSIFICATION OF FARM OPERATING UNITS

Location, size, and tenure are three variables commonly used for classifying farm units in Census tabulations. In addition, farm management analysts have given considerable attention to various systems of classifying farms according to principal enterprise combinations, distinguishing specialized crop or livestock units from various classes of diversified units. When interest focuses on the results of decisions by farm operators, it is equally important to try to classify the operators themselves, according to factors which are likely to influence their choices in planning and directing their farm business activities. All of these variables will be considered in the classification of farm operating units in El Salvador, but before discussing them further, definitions are needed for the farm operating unit itself and for its operator, also known as the producer. In examining the real significance of these definitions, a considerable start will also be made toward identifying the tenure classes used in the Census and in the present analysis.

Defining the Producer

The 1961 Agricultural Census was based on definitions of the producer and of his farm unit which correspond closely to those used in many other countries where recommendations of the United Nations Food and Agriculture Organization (FAO) have been wholly or substantially adopted. The Census definition of the producer is as follows:

"The Producer (El Productor) is the natural or corporate person who has the technical and economic initiative and the principal responsibility in management of the farm business unit. The producer may manage the unit personally or through a hired manager or person in charge."

It should be noted that the landowner does not automatically become the producer under this definition--a point which is sometimes very difficult for interviewers in Latin America to grasp, because of his general prestige and the extent of the control which he is capable of exercising over the use of his lands. In practice, of course, the principal responsibility for management may pass from the landowner to a cash renter, a renter paying in a specific quantity of product, a sharecropper, or a person making use of the land under some other form of tenure.

An important clue to identifying the producer in such cases is to identify the principal risk bearer. Ordinarily, a person who invests resources in production activities for his own account and at his own risk

can be considered the person holding the economic initiative. Such a person cannot really avoid responsibility for the final consequences of production decisions, although he may delegate much of the actual administration to a hired manager or other employee. In many cases, of course, the farm operator's activities include no direct participation in the physical work of caring for crops or livestock, being limited solely to contributions of an entrepreneurial order.

Instead of being a natural person, the producer may very well be a corporation or partnership, represented by one or more executives, managers, or spokesmen. In such cases, it may become relevant to consider characteristics and motivations of both the organizations and the persons who represent them.

The 1961 Census recognized a special type of worker and producer, known as the Colono, who "(1) resides permanently in a rural property; (2) has received from the owner or manager of such a property one or more parcels of land, of whatever size, for agricultural production; and (3) pays compensation for the land he receives in any form, be it by work on the property, by delivery of part of the crop, or by some other means."

Ordinarily, the colono is primarily a farm laborer, who has been granted a small residential site on a rural property so that he will be available for employment by the day when needed. The minimum residential site usually includes a small area for production of subsistence crops. In addition, the colono often receives a larger plot of from 0.25 to 3 hectares or more, ordinarily for production of cereals, for which he may pay cash rent, a share of the crop, or a specified amount of labor.

Sometimes a field to be divided into such plots is plowed and harrowed with tractor equipment at the expense of the landowner, who may also contribute all or part of the seed and fertilizer, especially if he is to receive some share of the crop. In such cases it becomes a moot question as to whether the landowner, the colono, or both should be considered the producer. Both may share in the decisions and the risks of the venture, and in one sense a partnership has been established, of very limited scope and for very limited objectives. The land involved, however, usually reverts to the landlord's unit after the harvest of a single crop, and crop residues may be grazed by the landlord's livestock; hence, it seems more reasonable to consider the colono sharecropper as being more akin to a laborer remunerated on a profit-sharing basis. Much of the risk, in the final analysis, may also revert to the landlord, since he commonly feels an obligation to provide enough foodstuffs to assure the survival of his colonos when crops are unfavorable.

Although the colono-sharecropper can seldom be considered a fully independent producer, colonos who pay cash rent for plots of appreciable size are scarcely distinguishable from other renters who do not happen to reside on the property where their rented land is located. In both cases, the rental agreement extends only to use of the land for production of a specific crop, in a single season, with the result that such individuals may not even be properly classed as producers throughout a complete agricultural year. For the purposes of this analysis, they have been counted among other producers--a procedure which leaves something to be desired, since their land may actually pertain to a different production unit during part of the agricultural year.

Defining the Farm Operating Unit

The 1961 census definition of the Farm Operating Unit was as follows:

> The Farm Operating Unit (Explotación Agropecuaria) consists of all land wholly or partially used for agricultural production by the producer, with or without the assistance of others and without reference to size or title. It may include one or more lots or parcels, provided they are located in a single municipio and are wholly under a single administration. It is also possible for an operating unit to extend into two or more adjoining municipios.

This definition clearly establishes the census unit as being one of administration rather than of ownership. A single unit may combine both owned and rented parcels, as long as these are operated under a single management. On the other hand, a given property may be divided among various operating units if the economic initiative is divided among various individuals. This applies especially to simple renting (arrendamiento simple), to sharecropping (aparcería), and to the use of land by colonos (colonato).

The case of simple renting represents the transfer of land use rights for specified purposes during the growing season of a particular crop or for an entire year, in consideration for which the renter delivers to the owner a specified quantity of money, a specified quantity of products, or a combination of both. In a few cases encountered in the field survey, the term was extended to include land ceded without specific consideration, usually to a relative or friend of the owner. Sharecropping was also considered a special form of renting, although it is not entirely clear that sharecropping was to be included in the category of simple renting under the census definition.

In any event, the case of sharecropping is characterized by the delivery of some proportional part of the harvest from rented land. In El Salvador, such an arrangement seldom if ever extends to more than one or two

crops produced during a specific harvest season, so there are few if any renters corresponding to the North American share tenant, who takes over an entire farm unit and operates it during a period of several years, paying a share of the total output as rent. In El Salvador either a colono or a nonresident renter may continue as a sharecropper on the same property for several years, but normally he will work only a small fraction of the total property in any one year, and his assigned area will probably not remain the same for more than a year or two.

As already noted, the colono-sharecropper, like other sharecroppers, can scarcely be considered a wholly independent producer. Commonly, he may choose the cultural practices to be followed for his particular crop, and he has a considerable responsibility for the detailed timing and execution of these practices. He has little to say, however, about the basic system of land management over the long term, since this is determined by the landowner. Perhaps it is most realistic to think of the sharecropper as an associate producer, whose activities are subordinated to a considerable degree of control by the landowner. However, since units operated by colonos were treated as separate operating units in the census, a similar procedure was adopted for the present analysis.

In certain cases, the census definition of a farm is too narrow to reflect the complete operating unit from the point of view of management. An example is provided by the landowner or renter who engages in agricultural production on two or more parcels not in contiguous municipios. Such cases are not uncommon in El Salvador. Notes made informally in the course of the field survey indicate that at least 20 of the 300 operators had one or more additional units in noncontiguous municipios, and other multiple holdings represented in the sample may have remained unidentified.

In El Salvador, as in many other countries, there are also many farm businesses which are partially related, from a management viewpoint, to other operating units within agriculture or outside of the agricultural sector. A simple example is provided by one of the survey respondents in Jiquilisco, who regularly operates 20 manzanas of land which he owns, and who also formed a temporary partnership with a relative not of his immediate family for the sole purpose of growing cotton on a large tract of rented land during the 1968 crop season. Under census procedures these are properly treated as separate operating units, but from a management viewpoint they are by no means wholly independent.

In another case, a successful farmer has been helping each of his several sons to establish themselves as farm operators. Some of the sons are now landowners, some are renters, and some fit the definition of colonos resident on their father's property, yet all assist their father in the farming operations on land which remains under his control. Each son is primarily concerned with managing his own farming activities, but he is at

least secondarily concerned with the management and success of the father's business, and the reverse is also true. Much more complex cases of interlocking farm operating units are frequently encountered.1/

Farm operators also may have extensive interests in nonagricultural operating units. In some cases, such units involve marketing or processing services for agricultural products, such as provided by a rice mill, a sugar mill, or a jam-making plant; in other cases the activity is much less closely related to the agricultural sector. Among the farm operators encountered in the field survey were the owner and operator of a bus line, a cattle dealer, many small merchants, the proprietor of a dental laboratory, several persons with extensive holdings of city rental property, and various professionals such as physicians and lawyers. The farms of such individuals can scarcely be considered completely independent economic operating units, inasmuch as the proprietors are subject to continuing incentives for reallocating their total resources of capital, managerial effort, and labor among the several enterprises.

In many respects, then, the census definition of a farm operating unit is a rather arbitrary necessity for purposes of enumeration and classification, rather than an exact means of identifying independent and wholly meaningful units of administration. In some cases, a single complement of resources is subject to allocation and reallocation among partially separate units of the same entrepreneur; in many other cases, production activities on a given unit result from the joint decisions of semi-independent producers and resource owners. In either event, the decision maker may face more complex problems than those of the typical firm considered in conventional economic theory.

Moreover, if it is true that the farm business as defined by the census is not necessarily an independent management unit reflecting the total productive activity of the operator, it is even more true that the earnings from that business may not represent the total income of the farm family. This is significant because problems of physical productivity and of human welfare must almost always receive joint consideration in planning public policies for agriculture. In analyses relating to the bulk of the rural areas of the United States, it has been customary, and not grossly inaccurate, to treat the land ownership unit, the farm operating unit, and the family income unit as almost synonymous. The existence of tenant farmers and income from off-farm employment has been recognized, of course, but the full-time owner-operator has been the stereotype of North American agriculture. In many parts of Latin America, including El Salvador, on the other hand, he may represent only a minority of all farm operators. Thus, the size and income potential of farm operating units in El Salvador cannot automatically be related to the welfare status of the operators and their families.

1/ See, for example, a case from the Sábana of Bogotá, cited by Wheeler and Guerra in Administración Rural en la Reforma Agraria y el Desarrollo Económico, Facultad Nacional de Agronomía, Medellín, Colombia (1963) Chapter VI.

The Location Variable

The 1961 census provides considerable information about farm operating units in each of the 14 departamentos and 261 municipios of El Salvador. These data suggest that there is more variability within the departamentos than among them. The total agriculture of the country is scarcely homogenous, but there is little that can be done to identify a few sharply defined major regions. A coastal plain extends along much of the southern part of the country, and a chain of mountains marks the northern (partially undefined) border with Honduras. A number of river valleys traverse the country in a generally north to south direction, and a chain of hilly areas running from east to west across the central part of the country contains the bulk of the country's coffee and citrus plantations. Production of corn is almost universal, and cattle production is almost as widely distributed, while most other agricultural enterprises are found on such a limited and scattered basis as to have no real regional differentiation.

For these reasons, it proved impractical to follow the original intention of conducting the field survey in about four sample municipios representing as many distinctly different areas or regions. Instead, the survey was spread over a total of six municipios in different parts of the country.

Each of the chosen municipios included a considerable area of Class I land, as identified in a land use capability map prepared under the joint auspices of various international organizations.[1/] Areas of very limited agricultural potential were purposely under-represented, inasmuch as an important purpose of the survey was to throw light on possibilities for intensified agricultural production. The principal coffee areas were also under-represented, partly because of their restricted opportunities for drastic change and partly because a United Nations team is currently examining diversification opportunities. The geographic distribution of the six municipios appears in Figure 1.

Although each of the six municipios has its distinctive characteristics, the results of the field study offered no impelling reasons for devoting much space in this report to separate analyses of the results. Hence, data from the six municipios were presented in consolidated form. Jiquilisco, Moncagua, Caluco, and Nueva Concepción fall in zones classified as having a hot climate, while El Porvenir and Cojutepeque have somewhat cooler climates. The latter municipio is in broken terrain not far from San Salvador and has considerable production of coffee, oranges, and various other fruits and vegetables. Caluco is slightly further removed from San Salvador and has sizable areas of well watered pastures used for fluid milk production, with a scattering of coconut palms interspersed in the pastures. Jiquilisco is an important cotton producer on the coastal

1/ Hector González Luna (1968). Zonificación Agropecuaria y Forestal en El Salvador: Guia para una Planificación del uso de la tierra. Instituto Interamericano de Ciencias Agrícolas de la O.E.A., Turrialba, Costa Rica.

plain, while the remaining three municipios are principally devoted to the production of cereals and cattle. Few sharp differences in size of unit, tenure, and other characteristics stood out in the data obtained from farms in the six municipios, although they were by no means completely uniform.

The Size Variable

The 227,000 units enumerated in the 1961 census ranged in size from small fractions of a hectare to more than 5,000 hectares. Nearly half the total number of units were of less than 1 hectare in size. Observations made early in the course of the field survey confirmed the supposition that production from such plots is limited to satisfying a part of the subsistence needs of colonos, other farm laborers, and some nonagricultural workers who reside in rural areas, with almost none of the output moving into commercial channels. Such units were classed as "Very Small" for the purpose of the present analysis, and were not represented in the sample of producers interviewed in the field survey. In many respects, however, the 107,000 or more very small producers face circumstances and problems essentially similar to those of an important fraction of the next larger size group.

The bulk of the farm units covered in the field survey ranged between 1 and 500 hectares in size, and were subdivided into "Small", "Medium" and "Large" groups for purpose of analysis. The class limits and numbers of sample farms for each size group, and the corresponding number of units reported in the 1961 census, are as follows:

Group	Size Range In Hectares	Units in Sample		Units in Census
		Preliminary	Detailed	
Small	1 to 9.9	159	39	100,265
Medium	10 to 49.9	76	22	15,235
Large	50 to 499.9	50	12	4,048
		285	73	119,548

The schedules from the preliminary survey were examined in some detail before the upper and lower limits for the medium group were finally established. At first, it seemed more plausible to set the lower limit for this class at 5 hectares. The possibility of establishing two intermediate classes with limits of 5 to 19.9 hectares and 20 to 49.9 or 99.9 hectares was also considered. Examination of the records suggested that many of the units in the 5 to 9.9 hectare class were much like those under the 5 hectare limit except for the addition of a few more hectares of rough grazing land, whereas those to 50 hectares or more resembled the units of 100 to 200 or more hectares rather closely. After setting the upper limit of the small group at 9.9 hectares and the lower limit of the large group at 50 hectares, no further subdivision of the middle group seemed warranted.

The census enumeration also included 314 units of 500 hectares or more. As the field survey instruments and procedures were not specifically designed for the complex management situations sometimes encountered on such large units, particularly in areas of cotton production, the interviewers in Jiquilisco and Moncagua were instructed to avoid these very large units. In Caluco, El Porvenir, and Nueva Concepción, however, a total of 10 very large units, all with considerable emphasis on livestock and with large areas in rough grazing land, appeared in the preliminary survey, and one of the operators was interviewed in the more detailed survey.

The total number of schedules taken in the preliminary survey was reduced by five, owing to the fact that three showed no production, one was a duplicate, and one proved to be part of another unit.

The Tenure Variable

To permit comparisons with census data, the operator of each sample unit was classified as being an "Owner" (Propietario), "Renter" (Arrendatario simple), "Part Owner" (Propietario-Arrendatario simple), or "Colono-renter" (Colono).

In addition to the land operated by owners, renters, and colonos, the 1961 census found a considerable area operated under some other form of tenure (otra forma) such as land used under a land purchase agreement (Arrendamiento con promesa de venta) or land in an undivided estate (sucesión). Presumably the "other" category might also include certain public lands or institutional farms. For purposes of summarizing the field survey, units held under a purchase agreement were counted as rented parcels, in keeping with the literal meaning of the local terminology, whereas land used by an heir to an undivided estate was considered as in use by the owner, and hence not under a separate administration from any other land which the same individual may have been using.

The number of sample units with less than 500 hectares in each of four tenure groups appears below, together with the numbers of census units in the five roughly similar classes:

Group	Units in Sample (1 to 500 Hectares)		Units in Census (1 to 500 Hectares)
	Preliminary	Detailed	
Owners	192	46	60,754
Part Owners	55	22	22,119
Renters	19	2	19,010
Colonos-Renters	19	3	13,322
Others	--	--	4,323
Totals	285	73	119,528

Among the 314 census units with more than 500 hectares, only 15 were operated by renters or part owners, and all 10 of the sample units in this size range were full owners.

After comparing the distribution of the sample farms with the census distribution, it seemed adequate for the present analysis to combine them into two groups--those with relatively secure tenure and those with relatively insecure tenure. Producers who owned all or more than half of the land they operated, plus those with rented land under a purchase agreement, were included in the first group, along with a few who were technically renters but who seemed to have relatively secure tenure by virtue of renting land from a parent or close relative. Other renters and colono-renters were placed in the second group. Altogether, only 57 units fell in the second group, but most of them were small in size, with the result that 25 percent of the small operators had to contend with relatively insecure tenure.

Enterprise Combinations

The problems of managing a single-product farm are often simpler, or at least different, than the problems of managing a highly diversified business. An operator can develop a considerable amount of specialized technical knowledge with reference to a single enterprise, for example, more easily than he can for each of the six or eight enterprises encountered on many general farms. In some cases, he can also afford more specialized equipment. On the other hand, specialization in a single crop seldom permits full utilization of a permanent labor force, and risks are often high. The degree of specialization is therefore an important element in many classifications of farms according to type.

In some cases there is also good reason for classifying farms according to specific enterprise combinations. The corn-hog farm of the midwestern United States, for example, had a permanent identity which was very different from that of a great plains wheat farm or a New England dairy farm. A coffee finca in Colombia is also easily distinguished from a cattle hacienda. On the other hand, some studies classified farms in considerable detail according to enterprise combinations which proved to be rather transitory. When the farm resources and organization permit easy substitution of one crop for another, a useful classification should ordinarily be broad enough to remain constant over a period of years.

After considerable testing of more detailed alternatives, it was concluded that there would be little advantage in dividing the sample farms into more than four principal groups based on enterprise combinations. The four groups are as follows:

A. Farms with cereals only (including dry beans, which are often planted in association with corn).
B. Farms with permanent crops only (principally coffee farms, which often have citrus and bananas or plátano associated with the coffee).
C. Other farms without a commercial livestock enterprise.
D. Farms with commercial livestock (usually but not always with crops).

The first of the four groups includes a large share of the small farms and many of the medium farms in areas where coffee is not grown. Farms of the second group were not numerous in any of the six municipios except Cojutepeque, but a considerable number of them are probably to be found in other areas where coffee is important. The third group includes a number of producers with important cotton enterprises, and a number of cereal growers who have added watermelons or one or two other crops to their enterprise combination. It would also include a number of sugar cane producers. Farms in all three of these groups frequently have a cow or two, a few chickens, and perhaps some pigs, to provide milk, eggs and meat for home use, but they have no appreciable income from livestock production. A large number also have a yoke or more of oxen, mainly for work on the farm, but also sometimes available for performing hired carting or other work.

The fourth group includes all farms with commercial livestock. Two of the sample units in this group had small swine enterprises and a third had a commercial laying flock; all the rest had cattle herds. Nearly all the cattle herds produce some milk for sale, although infrequently from cows of true dairy breeding. All 10 of the very large farms and 42 of the 50 large farms fell in the fourth group, along with 50 of the medium farms and 25 of the small ones. Only 20 of the 127 producers in the fourth group grew no crops, and some of these appeared to be in a transitional stage of organization.

The Entrepreneurial Status of the Operator

As already noted, the management decisions of a given farm operator are likely to be strongly influenced by his age, education, family responsibilities, and other factors such as nonfarm employment and income, as well as by the physical resources of his farm and the institutional parameters of his environment. Accordingly, it seemed desirable to classify the farm operators themselves according to what may be termed their "entrepreneurial status".

After some experimentation and study of the individual records, the following groups were evolved:

1. Subsistence Producers - Those who produce little if any output for market.

2. Semi-Active, Commercial Farm Operators: Subgroup A - Those who produce for market but lack a long-range planning horizon or a physical capability for intensive effort.

3. Semi-Active, Commercial Farm Operators: Subgroup B - Others who produce for market but are not primarily dependent on farming for their income, mainly because of professional, commercial, or other nonfarm employment.

4. Active Commercial Farm Operators - Commercial producers who are primarily dependent on farming for employment and income, and who have a physical capability for intensive, direct effort, either personally or through the participation of a son or another family member.

The group of subsistence producers includes large numbers of (a) colonos who have been ceded very small plots by their patron, (b) owners of small or very small holdings, and (c) part-owners, renters and colono-renters who have been able to extend their units by renting a hectare or two to augment their subsistence production. Individual producers do not always remain for long in subcategory (c), partly because they are experiencing increasing difficulty in finding land to rent, and also because an unfavorable crop season can leave them with too little capital to undertake crop production in the following season. The latter happens often, partly because such land as can be found for rent tends to be of low productivity and is subject to high risks. If this kind of producer ceases to rent land on a cash or share basis, he falls back into subcategory (a) or (b). On the other hand, if he is successful in renting a sizable area of land, he may become a small-scale active commercial producer for a year or two.

A large share of all subsistence producers are primarily farm laborers, and it is very doubtful that more than a small number have the necessary knowledge, the management skills, and the minimum of resources to become successful small-scale commercial farmers. Probably few of them even aspire to do so, being quite willing, instead, to depend upon paid employment, providing it remains available. Unfortunately, this group is likely to suffer greatly if farm mechanization increases and the rate of population growth exceeds the development of new opportunities for employment in rural areas.

Subgroup A of the semi-active, commercial producers is composed principally of widows or operators approaching retirement who do not have a son or other relative interested in participating actively in the business. Units from groups 3 and 4 tend to slide into this class when the family does not include one or more sons interested in becoming farm operators. Also, the equal subdivision of a farm unit among several heirs often brings one or more parts of a formerly successful farm into this group.

Subgroup B of the semi-active, commercial producers includes many individuals whose interest in the farm business varies by spurts, according to the opportunities they perceive for obtaining favorable returns for the investment of such capital and personal resources as they may have available. Often, however, they are unable to provide the constant and detailed supervision necessary for the realization of anticipated returns. Even without operating profits, the upward trend of land values may lead them to consider farm ownership a relatively safe and productive way of investing capital earned elsewhere, so their holdings often include several parcels purchased at various times when opportunity presented itself.

Perhaps the largest 100 to 200 producers in Subgroup B should be identified as a separate Subgroup C, since their executive talents and their wealth enable them to employ well qualified farm managers, capable of farming effectively and producing a favorable return on invested capital. Such producers may be leaders in industry who also seek safe and remunerative investment opportunities in agriculture and have considerable access to credit and to the best technical information.

Procedures Used in the Field Survey

The background to the classification of farm units would not be complete without a few comments on procedures followed in the field survey. The first phase of this activity was designed to provide a quick and low-cost means of supplementing census data so as to permit a more adequate classification of El Salvador's farm operating units than would

have otherwise been possible. The schedule was brief, and six interviewers with some supervisory assistance completed the 300 interviews in a total of 10 working days, all travel time included. This was possible because the work was concentrated in six municipios and a cluster system of sampling was followed in each municipio.

Since the operating unit is frequently different from the property unit, and since there is appreciable change from year to year in the list of individuals currently operating farms, there was no complete list of farm operators available from which to draw a sample. However, a list of 15 to 30 farm operators was developed from various sources for each municipio, and interviewers were instructed to treat each of these as the nucleus of a cluster, composed of the named operator and his four or five nearest neighbors, including any renters or colono-renters within the properties involved in the cluster. This kind of technique was chosen to avoid the heavy bias toward selection of well-known and outstanding producers, which is a hazard in developing sampling lists at the county seat. It also helped to increase the output per interviewer, as some of the terrain had to be covered on foot and two interviewers usually worked from a single vehicle.

Because the neighbors of a given producer frequently appeared a second or third time in other clusters, only about two-thirds of the interviews proved to be with producers surrounding the listed individuals, instead of 70 to 80 percent as had been expected. Another result of the sampling technique was that the special extension of large units increased their probability of appearing as neighbors of the listed producers--a bias not inconsistent with the requirement for an efficient stratified sample. In this respect, the aggregate sample is not selfweighting, and the choice of municipios in a manner which underrepresents the coffee areas, while over representing the areas of Class I land in general, has already been noted. If, on still other counts, it may fall short of conforming to an ideal stratified random sample, there seems little reason to believe that it contains further biases which would materially reduce its value for the intended purpose.

Data obtained during the second phase of the study, when a fourth of the producers supplied additional information, revealed some inaccuracies in the responses noted on the preliminary schedules. This was not surprising, for various reasons, but in very few cases were the corrections of a sufficient magnitude to affect the classification of the unit in respect to the principal variables. In at least one or two cases, a recheck did show that some parcel of land pertaining to the operating unit had been omitted on the preliminary schedule.

It was correctly anticipated that the most serious problem for the interviewers would be to make a correct identification of the producer

and the exact area to be included in his operating unit. This problem was stressed in training before the field work was initiated, and the project adviser maintained a constant check on interpretations which were being made during the progress of the work through the six municipios.

The first hurdle was to distinguish between farm operators, landowners, and hired managers or caretakers, especially when each class of individual might be a producer on some part of a given property. (The landowner, for example, might rent out part of his property to a neighboring farmer, operate part for his own account, and permit the resident manager to grow his own commercial crop of corn on another part, while also ceding a dozen or more small subsistence plots to as many colonos residing on the property, and renting larger plots to several of them.)

The second hurdle was to make sure that all the parcels of a given operating unit were reported. With reference to farms of 1 hectare or more in size, the 1961 census revealed that nearly 40 percent consisted of more than one parcel, 2.2 percent included 4 parcels or more, and some 103 units, ranging in size from 5 hectares upward, represented combinations of 10 or more parcels. Even among the small census farms, 38 percent had two or three parcels, but only 1 percent of the small farms had more than three parcels, whereas this proportion increased to 8 percent for the medium farms and to 11 percent for the large farms. Very similar proportions were found in the various size groups of the 300 preliminary survey units, but it was also noted that only 2 of the 38 simple renters and colono-renters worked as many as two parcels.

All interviewers spent the first two days of their field work in the municipio of El Porvenir, to permit continuation of the training initiated on the preceding work day in the office. They were then divided in teams of two, and each team completed the field work in two of the six municipios during the two-week period. Work on the second series of interviews was scheduled during the following two weeks in such a manner that nearly every producer could be approached by the same interviewer he had met earlier.

This procedure was followed partly in the expectation that it would help to increase confidence before beginning the series of questions related to receipts and expenses of the farm business; the results were all that could be expected, and the interviewers almost invariably encountered a cordial reception on the return visit. Refusals were almost nil in both series of visits.

It was not always easy to make contact with the producers chosen for interviews, partly because a number of them lived at some distance

from the nearest motor road and partly because the place of residence was often in a village or city at some distance from the land used for farming. Also, since the interviews were conducted in the slack season for farm work, the producer was not always to be found at either his farm property or his residence. In a number of cases, managers or caretakers furnished the information for the preliminary survey, but data for the detailed survey were necessarily furnished by the producer himself, or in one or two cases by his spouse.