JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF WATER RESOURCES
REPUBLIC OF HONDURAS

FEASIBILITY STUDY ON THE IRRIGATED AGRICULTURAL DEVELOPMENT PROJECT IN JESUS DE OTORO, INTIBUCA DEPARTMENT

MAIN REPORT

MARCH 1994

KOKUSAI KOGYO CO., LTD.
NAIGAI ENGINEERING CO., LTD.

REPUBLIC OF HONDURAS
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PREFACE

In response to a request of the Government of the Republic of Honduras, the Government of Japan decided to conduct a feasibility study on the Irrigated Agricultural Development Project in Jesus de Otoro Valley, Intibuca Department and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to the Republic of Honduras a study team headed by Mr. Narumi Yamada, Kokusai Kogyo Co., LTD., three (3) times between October, 1992 and February, 1994.

The team held discussions with the officials concerned of the Government of the Republic of Honduras, and conducted a field survey at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Honduras for their close cooperation extended to the team.

March, 1994

Kensuke Yanagiya

KENSUKE YANAGIYA
President
Japan International Cooperation Agency

March 1994

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. K. Yanagiya,

Letter of Transmittal

We are pleased to submit to you the Final Report on the feasibility study on the Irrigated Agricultural Development Project in Jesus de Otoro, Intibuca Department in the Republic of Honduras.

The feasibility study of the Project has been conducted over an 18 months period, commencing October, 1992 up to March, 1994 in accordance with the terms and conditions of the contract concluded between your Agency and our firm. During the course of the study, the present situations of the Study Area have carefully been analyzed and the irrigated agricultural development plan as proposed in this study report has been formulated. The Project aims at enhancing agricultural development activities in the Study Area, leading ultimately to the upliftment of the living standards of the people in Jesus de Otoro Valley, Intibuca Department.

The Project consists of the two components; (1) the irrigation development scheme which contains eight irrigation sub-project areas with a total area of 3,359 ha; and (2) the rural development scheme which contains construction of an Agricultural Development Center and communal centers and improvement of rural roads. As a result of elaborate and careful study, the Project has been proved to be technically sound, economically feasible and environmentally viable.

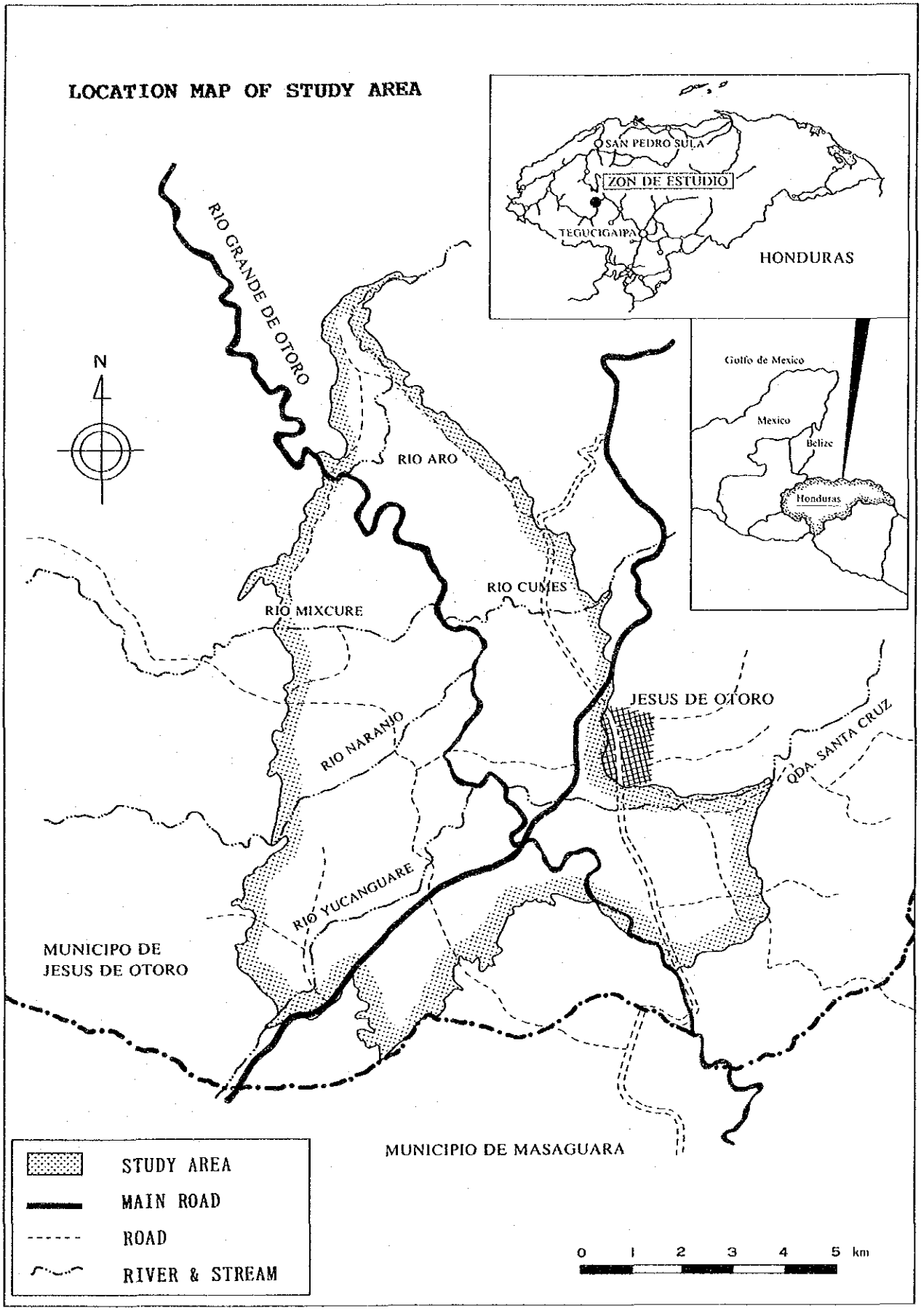
We wish to take this opportunity to express our sincere gratitude to the concerned officials and staffs in your Agency and the Ministry of Agriculture, Forestry and Fishery of Japan for their kind advice and assistance extended to the Study Team. We also wish to express our heartfelt appreciation to the concerned officials and staff members at, among others, the Directorate General of Water Resources of the Ministry of Natural Resources in Honduras, the Embassy of Japan, JICA Office, and JICA experts in Honduras for their cordial cooperation and assistance during our study work in Honduras.

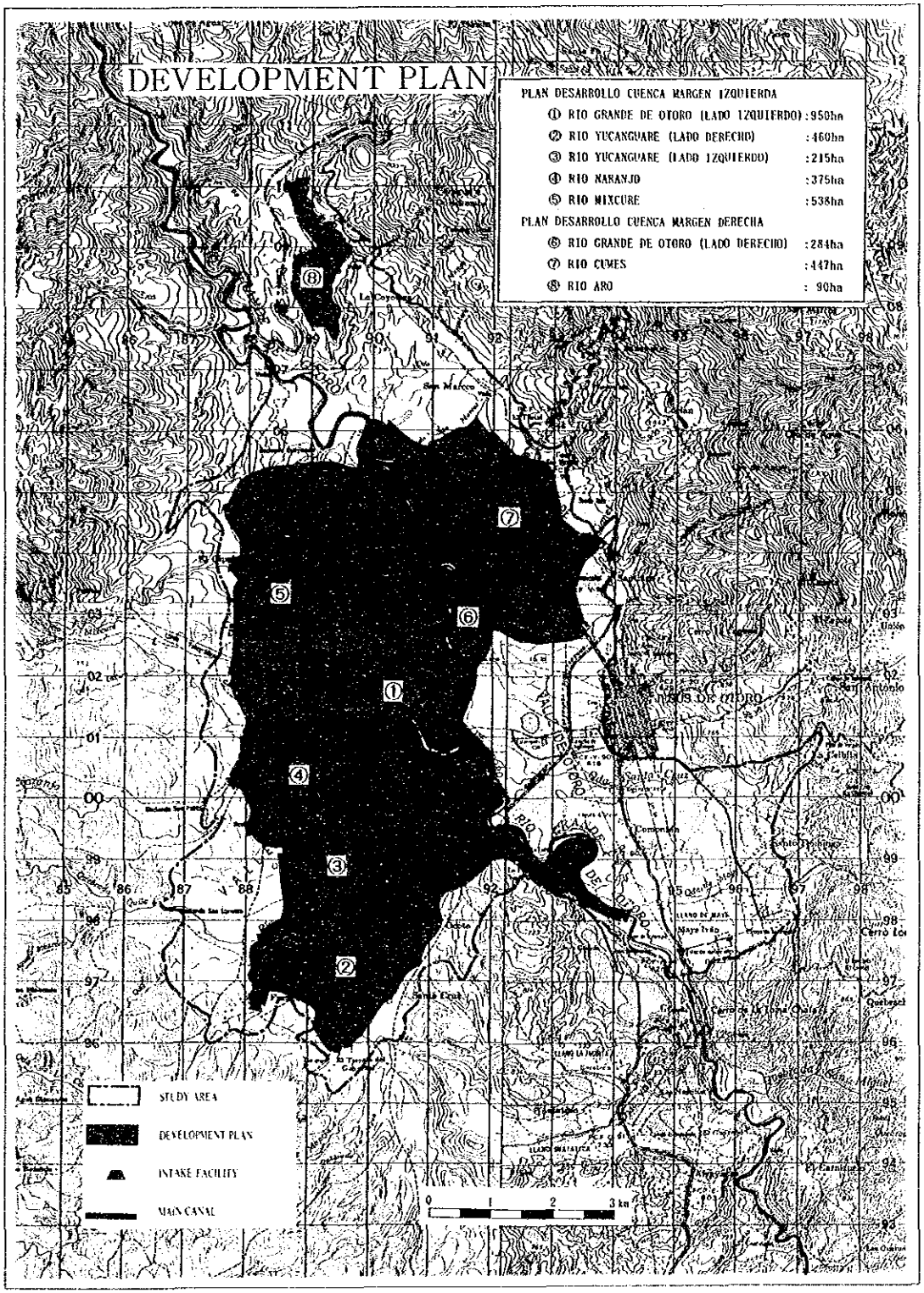
We sincerely hope that the authorities concerned would take a quick action for the early implementation of the Project proposed in this study report.

Very truly yours,

Narumi Yamada
Team Leader of the Study
on the Irrigated Agricultural
Development Project, Jesus de Otoro
Valley, Intibuca Department

Kokusai Kogyo Co., Ltd.


LOCATION MAP OF STUDY AREA
SAN PEDRO SULA
ZON DE ESTUDIO
TEGUCIGAIPA
HONDURAS
Golfo de Mexico
Mexico
Belize
Honduras
N
RIO GRANDE DE OTORO
RIO ARO
RIO CUMES
RIO MIXCURE
JESUS DE OTORO
RIO NARANJO
QDA. SANTA CRUZ
RIO YUCANGUARE
MUNICIPO DE
JESUS DE OTORO
MUNICIPIO DE MASAGUARA
STUDY AREA
MAIN ROAD
ROAD
RIVER & STREAM
0 1 2 3 4 5 km


DEVELOPMENT PLAN
PLAN DESARROLLO CUENCA MARGEN IZQUIERDA
① RIO GRANDE DE OTORO (LADO IZQUIERDO) :950ha
② RIO YUCANGUARE (LADO DERECHO) :460ha
③ RIO YUCANGUARE (LADO IZQUIERDO) :215ha
④ RIO NARANJO :375ha
⑤ RIO MIXCURE :538ha
PLAN DESARROLLO CUENCA MARGEN DERECHA
⑥ RIO GRANDE DE OTORO (LADO DERECHO) :284ha
⑦ RIO CUMES :447ha
⑧ RIO ARO : 90ha
STUDY AREA
DEVELOPMENT PLAN
INTAKE FACILITY
MAIN CANAL
0 1 2 3 km

SUMMARY

SUMMARY

1. Introduction

This Report presents the results of the feasibility study on the Irrigated Agricultural Development Project in Jesus de Otoro Valley carried out from October, 1992 to November, 1993 based on the S/W agreed upon on March 19, 1992.

2. Background

Agriculture sector is the mainstay of Honduran economy, contributing to 22% of the Gross Domestic Product, 47% of the economically active population and 80% of export earnings. However, the production of basic grains is unstable, they are still not self-sufficient and their importation is increasing every year. Moreover, the income disparity between rural areas and urban areas tend to increase. The Government makes efforts to solve these problems through the improvement of agricultural infrastructure, land reform and agricultural technology.

Jesus de Otoro Valley in Intibuca Department, which is an important supplying base of the basic grains, is blessed with natural resources in terms of topography, climate, water resources, etc. However, farmer's income is low and income disparity between the Valley and other areas are increasing because farming activities are basically concentrated on basic grains cultivation due to undeveloped agricultural infrastructure.

As the main roads connecting the valley with consumptive cities have improved recently, the exploitation of its potentials and agricultural development are urgent and important subjects.

3. Objectives of the Study

The objectives of the Study are to conduct feasibility study on the Irrigated Agricultural Development Project in Jesus de Otoro Valley and to carry out technology transfer to the Honduras counterpart personnel concerned.

4. Study Area

The Study covers Jesus de Otoro Valley (about 8,000ha) in Intibuca Department which is located at the western part of the central Honduras.

5. Present Conditions of the Study Area

(1) Topography

The Study Area is a valley stretching 16.5km from north to south and 5-8km from east to west. Grande de Otoro River flows the center of the valley from south to north, and many tributaries form complicated topographic conditions in the valley. Steep slopes appear in higher areas than EL.700m around the valley and they are connected with mountainous areas. Average ground slope

in direction form south to north is about 1/130 varying from 1/15 to 1/400.

(2) Meteorology

It is located in the subtropical highland meteorological zone, annual average temperature is 25.5 degrees centigrade and it changes little by month. Annual mean rainfall is 1,012mm which is characterized with two distinct seasons by the prevailing winds, namely the rainy season from May to October and the dry season from November to April. And 90% of the annual rainfall falls during the rainy season.

(3) Hydrology

The annual average discharge of the Grande de Otoro River at the La Gloria Station is 569.3MCM, and average runoff percentage is 48%.

The proposed water resources of the irrigation systems are the Grande de Otoro River and its 5 tributaries which have discharge even in the dry season, and their average annual and minimum monthly discharge (April) are as follows;

Discharge at the Proposed Intake Sites

Unit: MCM

	Grande de Otoro		Yucanguare		Naranjo	Mixcure	Cumes	Aro
	L.B.	R.B.	L.B.	R.B.				
AD	569.65	649.74	109.79	89.14	18.61	16.38	13.74	15.50
MMD	12.74	14.70	2.48	2.02	0.42	0.37	0.31	0.35

Note: L.B.: Left Bank R.B.: Right Bank
AD : Annual Discharge
MMD : Minimum Monthly Discharge

(4) Geology

All the Study Area is covered with sedimentary strata of quaternary period. These alluvial deposits form gravel terraces and flood plains. The alluvial sediments have been deposited not only around the rivers and streams but also in whole the valley with heavy thickness. Many faults are found in the mountainous areas around the valley, and it is supposed that they exist in the valley as well. According to the results of core drilling tests at the main construction sites, all N value show 50 or more at the bearing layer of the structure, they are very dense suitable for the foundation.

(5) Soils

The soils are classified into 15 types by their locations and characters such as thickness of the effective soil layer, degree of lightness and heaviness, content of gravel, stones and organic

matters. The soil classification is shown at the soil map. As a result of the land classification study in accordance with the USDA standard, the lands are classified into 7 evaluations. The alluvial soils along the rivers are highest, and lower areas of the Yucanguare River and the Naranjo River and the left bank of the Cumes River follow them. The lowestly evaluated soils located at the upper area of the Mixcure River and the right bank of the upper Cumes River.

(6) Land Use

The lands of the Study Area are used in 90% with agricultural use as arable land, grass land and copse-wood land. Staple foods such as upland rice, maize and beans are mainly planted on the arable lands, coffee and fruit trees are planted on the large farms near the mountainous areas. The grass lands and copse-wood lands range in considerably wide areas, and they are used as a base of animal breeding.

(7) Administration and Population

Honduras is divided into 18 departments, and each department is further sub-divided into municipalities (283 municipalities in Honduras) which are the smallest administrative unit. The municipality is divided into villages, but they are not administrative units and their boundaries are also not cleared. The Study Area is located in the Jesus de Otoro Municipality, Intibuca Department.

The population of the Jesus de Otoro municipality was 13,632 at the 1988 Census, and its average annual rate of population increase for 14 years was 3.69% which was almost the same as nationwide one (3.63%). The population of 31% resided in the urban areas.

The population of the Jesus de Otoro Valley in 1988 was 6,275 with 1,319 households, of which 73% are engaged in agriculture. Assuming the average annual rate of population increase is 3.6%, the population in 1993 is estimated as 7,500.

(8) Land Holding

In order to promote the land reform, the Instituto Nacional Agrario (INA) is conducting, based on the Land Reform Law, expropriation and distribution of lands, and it is promoting joint holding of the lands, joint work and operation of the cultivation by means of organization of farmer's groups and agricultural cooperatives. As most of their lands are lands with the right of tentative use, the Instituto Nacional Agrario is conducting the procedure to make them private lands.

There are 2 types of the land holding in the valley; one is private landholding and another is group holding. The groups are divided into agrarian reform groups (grupos campesinos) and non-agrarian reform groups (peasant groups). The land holding is as follows:

Type and Area of Land Holding

Type of Land Holding	No. of Household	Area (ha)
Private	644	5,500
Peasant group	98 (6 groups)	235
Farmer's group	156 (8 groups)	720

The farmer's groups shift to agricultural cooperatives which aim at agricultural production, further which aim at processing and selling under the guidance of the Instituto Nacional Agrario and the Ministry of Natural Resources. The peasant groups are supported in technology and finance by the Ministry of Natural Resources and the Agricultural Development Bank.

(9) Marketing

Rice is one of the basic grains and at the same time, it has a character of cash crop in Jesus de Otoro. However, definite marketing route of rice is not established yet. There are several marketing channels of rice; producers to middlemen; producers to cooperatives; producers to rice millers, etc. About 6% of rice produced in the valley is consumed in Jesus de Otoro municipality and the remaining are sold through the channels as mentioned above.

Almost all maize produced by small scale farmers are consumed by themselves and about 50-80% of maize produced by large and medium scale farmers and 50% of all frijoles produced in the valley are marketed through middlemen.

About 100t of tomatoes are estimated to be produced in the valley, and they are sold either to local market as fresh tomatoes or to the factory for processing. Its demand is expected to increase by 10% every year. Tomato processing factories in Comayagua have a plan to expand the processing capacity and to buy tomatoes from farmers in the Otoro valley under annual contract. Other vegetables are not produced enough to satisfy the demand in the valley.

Livestock production pattern is different depending on the farm size. In case of medium and small scale farmers, most of their cattle products are self-supplied and poultry products are sold, while in case of large scale farmers, most of their poultry products are self-supplied and cattle products such as beef, milk and cheese are sold through middlemen.

(10) Agriculture

Main crops in the Study Area are upland rice, maize and field beans (frijoles). Tomato production has tendency to increase though its production level is still low. Onions are partly planted. Aasparagus and grape are planted on a trial basis. Pasture lands cover a considerable part of the farm lands.

Upland rice and maize are planted from May to October, and field beans are planted from August to December. In the irrigated areas, upland rice and maize are planted from September to February, field beans are planted from January to April and tomatoes are planted from October to March. According to the questionnaire survey, 67% of all farmers planted upland rice, 93% did maize and 83% did frijoles.

Plowing and land preparation for 90% of all arable lands are carried out by rented tractors, and sowing and harvesting are carried out by animals or manpower. Tractors are possessed by 8 farmers and they conduct cultivation by contract. The Regional Office of the Ministry of Natural Resources at La Esperanza has 2 tractors, and they are also used for cultivation in the Study Area.

The exchange of seed for upland rice is done well. The sowing is carried out mainly by the row sowing. Chemical fertilizer and herbicide are used by all farmers. Insecticide is used by 81% of all farmers and fungicide is used by 18% of all farmers. The exchange of seed for maize is also done well, the sowing is carried out by the point sowing, and chemical fertilizer is used by 91% of all farmers, insecticide is used by 54% of all farmers, herbicide is used by 56% of all farmers and germicide is used by 1% of all farmers. The sowing of field beans is also carried out by the point sowing, and chemical fertilizer is used by 83% of all farmers, insecticide is used by 29% of all farmers, herbicide are used by 17% of all farmers and germicide is used by 1% of all farmers. As almost a half products of the maize and field beans is consumed by themselves, agricultural inputs for them are less than upland rice which is planted for selling. Some of insecticide and herbicide are not desirable for environment, and it is necessary to study to use them.

The upland rice is not planted with mix cropping, but the field beans is planted with mix cropping in more than half areas of the maize fields. The tomatoes and onions are transplanted after harvesting maize and frijoles.

Due to absence of the reliable agricultural statistics of the Study Area, the yields of main crops are estimated on the basis of the questionnaire survey, present land use survey and field investigation. They are shown bellow.

Average Yield of Main Crops

Unit: t/ha

Crop	Rainfed	Irrigated (rainy season)	Irrigated (dry season)
Upland rice	3.00	3.50	4.00
Maize	1.40	2.20	2.50
Frijoles	0.70	0.90	1.00
Tomato			8.72

Agencies and institutions providing agricultural supporting services in the Study Area are as follows;

- Extension Office of Ministry of Natural Resources: It conducts extension work, investigation, etc.

- Agricultural technical assistance by Spanish Government: It conducts education, technical extension and improvement of rural living conditions with counterparts of INA (Instituto Nacional Agrario) and MNR.

- FHIA (Fundacion Hondurena de Investigacion Agricola): It is a private foundation established in 1984 with assistance of USAID, Government of Honduras and private enterprises. It has trial farms in La Esperanza and Comayagua. It conducts soil survey, selection of crops, guidance of cultivating technique, guidance of management practices, guidance of integrated insect control, analysis of residual toxicity, post-harvest treatment, etc. onerously.

- EAP (Escuela Agricola Panamericana): It is a private collage established in Francisco Morazan Department, it is taking an active part in Integrated Insect Control Project.

- CEDA: It is established in Comayagua by Japanese assistance, and conducts training for irrigated agriculture.

- Agricultural Development Bank: It is a governmental finance authority, has a branch office in Otoro town. It loans out the finance for agricultural production.

Livestock sub-sector is an important industry in the Study Area. Grass lands and copse lands contribute to about 50% of agricultural lands where 6,000 cattle are bred in 95 stock farms. In addition, cattle and horses for labor, pigs and fowls are bred. Fertilizer is generally not applied in the grass land, and few grass is irrigated during dry season. About 70% of cattle reduce their weight and 3% die during the dry season. There is no death of cattle during rainy season.

(11) Irrigation and Drainage

Irrigation facilities in the Study Area include 40 intake facilities in 9 tributaries constructed by groups or individuals, with the total irrigation area of 3,000 ha. Most of these intake facilities are constructed by piling up river stones, and they are destroyed by floods every year. The height of weirs constructed with stones and concrete is 0.5-1.0 m, and only one weir constructed on the Mixcure River has a sand sluiceway at the center of the weir. The height of weirs constructed with stones is 0.3-0.5 m, and they have no intake gates.

Outline of Existing Irrigation Facilities

River	River stone	Concrete Fixed	Total	Irrigated Area (ha)
Yucanguare	8	4	12	528
Naranjo	5	1	6	557
Mixcure	5	2	7	581
Santa Cruz	6	-	6	378
Cumes	1	1	2	426
Aro	2	-	2	36
Others	3	2	5	64
Total	30	10	40	2,970

The existing canals are constructed with river stones, but concrete or pipes are used at the sites with limited lots or steep slope. All main canals are unlined and constructed making approximately a right angle with contour lines. The secondary canals are few and almost of all irrigation are carried out by plot-to-plot type irrigation.

The Government of Honduras is promoting farmer's organization to take over and to conduct operation and maintenance by themselves excepting large scale facilities such as dams.

The operation and maintenance of the existing irrigation facilities in the valley are individually carried out by beneficiaries of each irrigation system under the guidance of Otoro Office of the MNR, but farmers lack understanding the necessity of maintenance. There is no organization uniting these irrigation systems. Each river has several irrigation systems where troubles concerning irrigation water distribution occur often. In 1991 when there was a heavy drought, an organization for water distribution and management was established by the MNR, Otoro municipality and farmers' representatives for coordination of water use.

A main drainage river is the Grande de Otoro River, its tributaries are rushing streams due to the topographic conditions and erosion make their river beds considerably lower than the ground elevation around the tributaries. The Grande de Otoro River is also in the same condition. Damages by flood, therefore,

hardly occur. But some parts of lowland are swampy where drainage on farm is necessary.

(12) Rural Infrastructure

The SECOPT (Secretaria de Comunicaciones, Obras Publicas y Transporte) constructs and controls the road network in the Valley, which is composed of asphalt paved road of 70 km with 7.2 m in width and 4 gravel roads of 89 km in total. The total length of other rural roads is 62 km, and they are impassable during rainy season.

The Study Area is interconnected through a transmission line of 34.5 kv with Siguatepeque City, which supplies energy to 490 subscribers in Jesus de Otoro town and 28 in Masaguara. Other villages lack electric supply because the installation costs are charged to the beneficiaries.

The existing water supply systems consist of water sources from rivers, streams and springs, distributing water by gravity systems, which have been installed or under planning in almost whole Study Area.

Jesus de Otoro has transportation service by regular bus, but its frequency is few.

The telephone system consists of a public telephone which allows communication to any parts of the country and a telephone network for internal use within the valley. A telegraph office and a mail office are in the Jesus de Otoro town.

Jesus de Otoro Municipality has a health center with a physician in Otoro town and 2 rural health centers with auxiliary nurses in San Rafael and San Jeronimo. Malaria ranks the first as the severe disease with the highest incidence in the area, followed by gastrointestinal infections and malnutrition cases among the infant population.

Jesus de Otoro Municipality has 37 elementary schools and a secondary education school is in Otoro town. The teachers are in charge of several grades simultaneously due to lack of teachers.

6. Basic Concept of Irrigated Agricultural Development

The elements which impede the development in the Study Area are; (a) poverty of peasant; (b) inadequate irrigation facilities and their operation and maintenance; (c) insufficient agricultural machinery; (d) insufficient personnel and equipments in agricultural extension; and (e) impeded transportation of agricultural inputs and products due to the inadequate roads.

To overcome the problems as mentioned above, the basic strategy for the development has been formulated taking into consideration the development policy of the Honduran Gvernment: (a) to increase basic grains production for stabilized supply of staple foods, (b) to introduce cash crops (vegetables) to improve the earning differentials between rural areas and urban areas, (c) to

introduce a gravity irrigation system to effectively develope water resources with materializable scale, (d) to improve rural infrastructure such as roads, water supply, etc. and (e) to formulate supporting plan for farmer's organization.

Based on this strategy, the basic concept of the Project has been set up as follows.

(1) Irrigation plan

In spite of the fact that the Grande de Otoro River contributes 74% of all water resources in the valley during dry season, it has never been utilized. At the formulation of irrigation plan, utilization of water resources of the Grande de Otoro should be given priority. The irrigation plan of the Grande de Otoro should be designed so as to include as much farm land of tributaries as possible even if those farm land at the tributaries are already irrigated by the water sources from the tributaries. By doing so, surplus water produced by it will be used for the development of new irrigable areas.

For the reasons that the Grande de Otoro River has discharge enough to irrigate the whole valley area even during dry season and the tributaries have no suitable dam sites for reservoir, an irrigation plan with reservoirs has not been considered.

(2) Cropping System

From a viewpoint of increasing the production of basic grains and introducing cash crops for increase of farmer's income, basic grains will be planted during rainy season and cash crops such as vegetables will be introduced during dry season. Considering the imporance of livestock farming, irrigation will also be applied for pasture land.

(3) Rural Infrastructure Development Plan

A rural road network connecting farms and villages with main roads will be designed, taking into consideration the management roads for irrigation facilities.

Water supply plan has not been considerd as water supply systems covering most of the Study Area have already been implemented or planned by the concerned agencies and institutions.

Facilities to promote upgrading of agricultural technology, active farmer's organizations and women's activities will be planned.

(4) Farmer Organization Plan

Farmer's organizations for operation and maintenance of irrigation facilities will be planned. Marketing organizations will be studied as well.

(5) Project Implementation Plan

Priority ranking of each sub-project (irrigation scheme) will be

examined in due consideration of such factors as economic rate of return, number of beneficiaries, irrigated acreage, condition of water resources, easiness of construction and accessibility (or demonstration effect). Project implementation plan will be formulated according to its priority ranking.

Special attention should be paid to the point that the sub-project area of the Grande de Otoro River should be given the first priority because of higher importance of the development of the water resources of the same and from a viewpoint of conservation of the existing custom right of water use in the existing irrigation areas which will be covered by the sub-project of the Grande de Otoro River.

7. Land Use Plan

The lands in the Study Area have a high potential from the viewpoint of its flat topography and thick effective soil layers. However, a part of lands have problems such as thin effective soil layers, insufficient soil moisture, poor drainage, and soil layers rich with gravel and stones.

The land use plan after completion of irrigation development is shown bellow.

Land Use Plan

Unit: ha

Sub-Project	Rainfed		Irrigated		Copse Land		Others		Total
	Pr.	Plan	Pr.	Plan	Pr.	Plan	Pr.	Plan	
Otoro L.	60	0	315	760	431	8	144	182	950
Otoro R.	176	0	50	227	51	39	7	18	284
Yuca. R.	122	0	228	368	97	61	13	31	460
Yuca. L	18	0	110	172	82	29	5	14	215
Naranjo	0	0	223	300	147	55	5	20	375
Mixcure	0	0	137	430	397	82	4	26	538
Cumes	40	0	271	358	111	46	25	43	447
Aro	57	0	19	72	13	13	1	5	90
Total	473	0	1,353	2,687	1,329	333	204	339	3,359
S.Area	2,670	2,197	1,800	3,154	2,290	1,294	1,360	1,495	8,140

Note: 1/ Rainfed and irrigated areas include pasture.
2/ Pr. = Present
3/ L. = Left
4/ R. = Right
5/ S. = Study

8. Farming Plan

(1) Proposed Cropping Pattern

Selection of crops has been determined in consideration of the national policy, soils, meteorology, marketability, technology and experiences of farmers and intention of farmers. Proposed crops are upland rice, maize, frijoles, vegetables (tomato, onion, eggplant, cucumber, field pea, string beans, etc.) and grass.

Cropping pattern should be formulated in considering that spread of damages by blight and harmful insects is expected by continual planting in rainy season and dry season. In order to avoid all the year round existence of mosca blanca, only gramineous crops will be planted during rainy season when blight in vegetables will be apt to break out.

Cropping pattern is proposed as follows;

- upland rice: double cropping during rainy season and dry season
- maize: cropping only during rainy season
- field beans and vegetables: rotation cropping only during dry season
- grass: cropping all the year round

(2) Proposed Yield

Present and proposed yield of each crop is as follows;

Average Yield of Main Crops

Uunit: t/ha

Crop	Present (Rainfed)	Present (Irrigated)		Proposed (Irrigated)	
		Rainy	Dry	Rainy	Dry
Upland rice	3.00	3.50	4.00	6.00	7.00
Maize	1.40	2.20	2.50	4.00	
Frijoles	0.70	0.90	1.00	-	1.50
Tomato			8.70		29.00

(3) Farm Labor

Farm labor of about 2,900 persons from 965 farm households is available in the Study Area. Though the labor is short at the periods of nursery, sowing and transplanting of vegetables, and of threshing of paddy, there are employable labor of about 2,800 persons at present within the Study Area which is enough to meet the requirement of labor. The necessary number of tractor will be less than present one, and the existing number of tractors will be enough.

(4) Livestock

The grazing capacity in the Study Area is presently 8,100 heads in terms of 250 kg per head. The grazing capacity will be 8,900 heads after completion of the project which means that the

capacity will increase even though the area of grass lands will be decreased.

9. Farmer Organizations Supporting Plan

(1) Agricultural Development Center

In order to implement smoothly the Irrigated Agricultural Development Project in Jesus de Otoro Valley, an agricultural development center including farmer's center, office, laboratory, demonstration farm, etc. will be established at the site of the current Agricultural Extension Office. In addition to the current activities of agricultural extension services and research works, this center will also conduct such activities as management of construction during the construction stage, guidance of operation and maintenance of the Project facilities until the facilities will be transferred to farmers, organization of water user groups marketing groups, etc.

(2) Organization and Operation of Water Users Aassociation

Water users associations (WUAs) will be established in each irrigation sub-project area in accordance with "General Law for Water". Firstly, irrigators groups will be organized in each tertiary canal, and secondary canal groups will be organized in each secondary canal, then canal groups will be organized in each main canal. Finally, a water users association will be organized at each sub-project area. Unifying all WUAs, a water users association union will be established covering eight sub-project areas.

Although the detailed organization of each WUA will be stipulated in the articles of the association, a WUA generally be headed by a representative, an operation manager, a maintenance manager, and an administrative staff who will be elected by members of the association. The water users association union is generally composed of a board of directors which is broken down to a chairman, a deputy chairman, a secretary, a treasury and an auditor. The union will have its general meeting where any issues will be discussed and resolved.

The main activities of the water users association union will be formulation of farming plan and water distribution plan, operation and maintenance of the irrigation facilities and management of collected water charge, and its base will be placed at the Agricultural developmetn Center. Based on the irrigation association union's decision, the irrigation associations will conduct operation of gates, usual maintenance and collection of water charge.

(3) Organization and Strengthening of Agricultural Cooperatives

Several farmer organizations such as farmers' groups, cooperatives and associative enterprises (a kind of cooperative) are presently active in Jesus de Otoro Municipality. Under the proposed Project, the necessity of organizing more farmer organizations will arise as a result of increased and diversified agricultural production. Such farmer organizations will aim at

providing financial support for crop production, purchase of agricultural products, processing and marketing.

The farmers' groups at the reformed sector can be upgraded to become members of the existing associative enterprise, named "EACTSO". It is recommended for farmers at non-reformed sector to organize cooperatives in accordance with the terms and conditions sipulated in the Cooperative Law. In that case, technical advice and training program are available through IHDECOOP (Instituto Hondureno de Cooperativas) and CHC (Honduras Cooperatives Federation).

It will be necessary to set up new cooperatives as a result of increased production of basic grains and cash crops under the Project. A preparatory committee to organize a cooperative will be organized in each sub-project area. At the first step, two cooperatives will be established, one each at the left bank area and right bank area of the Grande de Otoro River. At the initial stage, the cooperatives' main task will be to provide loan for crop production and livestock farming, supply of agricultural inputs. At the later stage when the production level will have been stable, their task will be expanded to the processing and marketing activities. The farmer'center at the Agricultural Development Center can be utilized for their activities.

10. Irrigation and Drainage Plan

(1) Water Requirement

The basic intake rate was less than 50 mm/hr from the result of field permeability tests, considering topography, soils and crops, furrow irrigation method is adopted.

The evapotranspiration is estimated by modified Penman method based on data of La Grolia Meteorological Station, recommended value by FAO is adopted for crop coefficient, and effective rainfall is estimated so that less than 5mm is zero,and that maximum effective rainfall is the total readily available moisture (TRAM), 49.4mm, in daily rainfall of 1/5 probability year. Proposed water requirement with irrigation efficiency of 46% is as follows:

Proposed Water Requirement

Unit: mm

Crop	1	2	3	4	5	6	7	8	9	10	11	12	Total
Rice (R)					35	75	129	144	29				412
Rice (D)	242	137								32	175	205	791
Maize						0	0	117	77	0			194
Fri-jol	202	34									23	179	438
Vege-table	243	275	150								16	135	819
Grass	178	200	280		275	135	34	30	48	55	63	121	138 1,557

Note: R = Rainy season; D = Dry season

(2) Irrigation System Plan

1) Grande de Otoro River

Hilly lands with El.700-800 m stand out at the left bank of the upper river. Considering this condition, the diversion weir site is decided where the design headwater level is El.592 m so as to make irrigable area in the left bank of the river maximum. As to the right bank of the river, the diversion weir site is decided where the design headwater level is El.566 m as a result of alternative study of 3 diversion weir sites, i.e. El.620 m, El.592 m and El. 655 m.

2) Yucanguare River

Due to topographical conditions, it is difficult to construct intake facility at the upper reaches of the confluence with the Quila Stream for the left bank of the river. Therefore, the diversion weir sites are proposed separately for right bank area and left bank area.

3) Other tributaries

One weir with outlet works on both banks for each tributary is proposed. As to the tributaries (Naranjo River, Mixcure River and Cumes River) which have not enough discharge during dry season and irrigable acreages are different between rainy season and dry season, alternative study was carried out; the alternative I is to irrigate whole area all the year round with 200% of cropping intensity; and the alternative II is to irrigate with maximum available water resources with 152%, 128% and 186% of cropping intensities respectively. As a result of the study, the alternative II has been selected.

The gross irrgation area of each irrigation system is as follows:

Area of Each Irrigation System

Unit: ha

Sub-Proj.	Irr.Area	Irr.Area Dry S.	New Area Irr. Area	Existing Irr.Area	Beneficiary Household (Estimate)
GOL	950	950	556	394	48
GOR	284	284	221	63	19
YUL	215	215	78	137	5
YUR	460	460	175	285	100
NAR	375	195	8	367	30
MIX	538	150	283	255	36
CUM	447	386	108	339	20
ARO	90	90	62	28	20
Total	3,359	2,730	1,491	1,868	278

Note:
GOL = Grande de Otoro Left Bank; GOR = Grande de Otoro Right Bank
YUL = Yucanguare Left Bank; YUR = Yucanguare Right Bank
NAR = Naranjo; CUM = Cumes; ARO = Aro
Irr. = Irrigated; L. = Left bank; R. = Right bank

(3) Drainage plan

As it is expected that there will be no damages by flood in the future, drainage plan with large scale is not necessary. A drainage system on farm will be sufficient.

A design drainage discharge is 6.11 lit/sec/ha which is estimated by rational formula adapting successive 3 days rainfall of 1/5 probability.

(4) Irrigation and drainage facility

Proposed irrigation and drainage facilities are as follows:

Irrigation and Drainage Facility

Sub-Project	Otoro L.	Yucanguare R.	Yucanguare L.	Yucanguare R.	Naranjo	Mixcure	Cumes	Aro
Irr.Area (ha)	950	284	215	460	375	538	447	90
Diversion Weir								
Length (m)	87.0	90.0	45.0	23.0	16.5	13.0	30.0	13.0
Height (m)	4.5	4.0	3.0	2.2	2.1	3.9	3.0	1.8
Design Headwater Level (ELm)	592.1	566.1	634.0	658.0	656.0	630.0	594.0	641.7
Design Diversion Requirement (m3/s)	0.72	0.22	0.17	0.35	0.29	0.42	0.34	0.07
Main Canal L. (km)	11.5	6.6	1.5	2.2	1.6	4.1	4.4	1.9
2nd Canal L. (km)	20.3	4.9	11.8	16.0	11.8	11.3	4.8	5.5
Management Road (km)	32.7	11.7	13.4	18.2	13.4	15.5	9.3	7.7
2nd Dr. Canal (km)	2.1	1.2	0.5	1.6	1.1	1.7	0.5	1.1
Land Consolid. (ha)	760	227	172	368	300	431	358	72

11. Rural Infrastructure Development Plan

(1) Road and Bridge

As existing rural roads are not passable during rainy season, a complete road network which connects farms and villages with main roads is planned by rehabilitation of the existing rural roads and by using proposed management roads of canals. Proposed rehabilitation routes are as follows:

- Route A: Guayabal-Route 22-30 — 2.16 km
- Route B: La Angostura-Route 22-30 — 1.2 km, 1 bridge (submerged bridge)
- Route C: El Cipres-Route 660 — 2.6 km, 1 bridge (submerged bridge)
- Aro River bridge on Route 670 (submerged bridge)

The SECOPT's design criteria are adopted considering operation and maintenance in future.

(2) Assembly Hall

In order to promote and activate farmer's organizations, 8 assembly halls with meeting room, office room, kitchen, storeroom, etc. are planned in Guayabal, La Angostura, Santo Domingo, San Lorenzo, El Cipres, El Porvenir, San Miguel and San Pablo.

(3) Agricultural Development Center

In order to strengthen agricultural extension works, an agricultural development center with demonstration farm (test farm) and laboratory is planned in Otoro branch office of Ministry of Natural Resources. It includes a building to be a center of farmer's organizations.

12. Organization for Project Implementation and Operation & Maintenance

This Project will be implemented by the Directorate General of Water Resources of the Ministry of Natural Resources in close collaboration with other concerned agencies such as SECOPT, INA (Instituto Nacional Agrario), INFOP, IHDECOOP, BANADESA (Agricultural Development Bank), etc. At the implementation of the Project, the Project Management Office composed of Construction Management Office (only during construction), Farmer Supporting Office and Operation and Maintenance Office will be established in the Agricultural Development Center. It will conduct management of construction and coordination of authorities concerned and farmers during the construction, and operation and maintenance of the constructed facilities, organization of water users associations, transfer of the facilities to farmers, formulation of facilities use plan and training of farmers after completion of the construction. This Office should be active as a central management office about 5 years after the completion of the construction to transfer constructed facilities to farmers. The operation and maintenance of the Project facilities will be conducted bt the water users associations after the transfer of the facilities.

13. Implementation Schedule and Project Cost

The Project, composed of eight sub-project areas, will be implemented in accordance with their priority ranking determined by several factors such as economic rate of return, number of beneficiaries, etc. The construction period will be 7 years.

The Project cost is estimated as follows:

Unit: 1,000 Lps,

Item	Foreign Currency Portion	Local Currency Portion	Total
Land Acquisition	0	4,446	4,446
Construction	99,990	81,746	181,736
(1) Irrigation	96,280	75,956	172,236
(2) Rural Development	3,710	5,790	9,500
O/M Machinery Procurem.	1,899	0	1,899
Engineering Services	7,537	5,915	13,452
Administration	754	592	1,345
Physical Contingency	5,509	4,635	10,144
Price Contingency	15,080	21,188	36,268
Total	130,769	118,521	249,290

Annual operation and maintenance cost is estimated at about 2 million Lps.

14. Project Evaluation

The results of the economic analysis of the Project are as follows:

Economic Internal Rate of Return (EIRR)		10.5%
Net Present Value (NPV)	Lps	6.7 million

The results of the sensibility analysis concerning future variation of economic conditions are as follows:

	EIRR (%)
(a) Project cost increase by 10%	9.4
(b) Project benefits decrease by 10%	9.3
(c) Combination of the above (a) and (b)	8.2

Farm household net income at the Project Area is expected to increase by 12 times (in case of small scale farmers) to 16 times (in case of large scale farmers) compared to the present income level.

Annual operation and maintenance cost of the irrigation facilities to be covered by the water users corresponds to 0.4 to 2.6 % of annual income of the farmers under the future with the Project condition, which falls within the range of capacity to pay of the farmers.

The Project will bring direct and indirect benefits as mentioned below:

1) It will contribute to self-sufficiency of foods, improvement of earning differentials between urban

area and rural area by increase of farmer's income, and increase of exportable crops production.

2) It will create employment opportunity for residents inside and outside of the project area.

3) It will activate rural economy by widening agricultural activities and by increase of farmers' buying power.

4) Improvement of living conditions and position of farmers and women by exchanging informations and training.

15. Environmental Evaluation

The General Law of Environment passed in the Congress of Honduras on May 27, 1993 and became effective on July 20, 1993. Evaluation of environment to be affected by this project was studied based on the Law. It is judged that there is not elements in the Project to be injurious to environment and natural resources in the valley because the Project does not include a large scale dam, a large scale land reclamation nor removal of residents. And there are also no important historical places, cultural inheritances, special designated areas nor habitats of important animals and plants.

However, in order not to decrease agricultural labor caused by diseases, it is important to protect farmers from malaria. It is also important for residents to have an interest in protection from water pollution and soil erosion of surrounded mountainous area and reservation of headwater conservation forests.

16. Conclusion and Recommendation

The Project is technically sound, economically viable and fit to environmental reservation. Accordingly, it is desirable to implement the Project and to achieve its goal as quickly as possible. The following recommendations are, therefore, made.

(1) An arrangement should be made for obtaining a loan or grant aid from international lending institutions or donor countries.

(2) An executing body such as the Project Management Office should be established.

(3) For the early achievement of the Project objectives, farmer organizations such as water users association and cooperatives should be strengthened. In this regard, technical assistance and guidance from the concerned agencies is indispensable at the initial stage of the Project implementation.

FEASIBILITY STUDY ON THE IRRIGATED AGRICULTURAL DEVELOPMENT PROJECT IN JESUS DE OTORO VALLEY, INTIBUCA DEPARTMENT

MAIN REPORT

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ABBREVIATION AND UNIT OF MEASURE

ABBREVIATION

AECI:	Agencia Española de Cooperación Internacional
AHPROCAFE:	Asociación Hndureña de Productores de Café
BANADESA:	Banco Nacional de Desarrollo Agrícola
B/C:	Benefit-Cost Ratio
BCH:	Banco Central de Honduras
BID:	Banco Interamericano de Desarrollo
CEDA:	Centro de Entrenamiento de Desarrollo Agrícola
CHICO:	Cámara Hondureña de la Industria de la Construcción
COHDEFOR:	Corporación Hondureña de Desarrollo Forestal
CRS:	Catholic Relief Service
CONAMA:	Comisión Nacional de Conservación del Medio Ambiente
DRWR:	Directorate General of Water Resources
EACTSO:	Empresa Asociativa de los Campesinos de Transformación y Servicios Otoreña
EAP:	Escuela Agrícola Panamericana
EIA:	Environmental Impact Assessment
EIRR:	Economic Internal Rate of Return
ENEE:	Empresa Nacional de Energía Eléctrica
FHIA:	Fundación Hondureña de Investigación Agrícola
IEE:	Estudio Inicial del Ambiente
IGN:	Instituto Geográfico Nacional
IHDECOOP:	Instituto Hondureño de Cooperativas
IHCAFE:	Instituto Hondureño del Café
IHMA:	Instituto Hondureño de Mercadeo Agrícola
INA:	Instituto Nacional Agrario
JICA:	Japan International Cooperation Agency

M/M:	Minutes of Meeting
MNR:	Ministry of Natural Resources
O/M:	Operation and Maintenance
RRNN:	Secretaria de Recursos Naturales
SECOPT:	Secretaria de Comunicaciones, Obras Publicas y Transporte
SECPLAN:	Secretaria de Planificación, Coordinacion y Propuesta
S/W:	Scope of Work

UNIT OF MEASURE

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
m^2	:	square meter
ha	:	hectare
Mz_2	:	manzana = 0.697 ha
km^2	:	square kilometer
m^3	:	cubic meter
lit	:	liter = 0.264 U.S. galon
g	:	gram
kg	:	kilogram
t	:	ton = 22.05 quintal (qq)
qq	:	quintal = 100 lb = 45.36 kg
lb	:	pound = 453.6 g
v	:	volt
kv	:	kilovolt
w	:	watt
mw	:	megawatt
%	:	per cent
°C	:	degree centigrade
s	:	second
min	:	minute
h	:	hour
Lps	:	lempiras
US$	:	U.S. Dollar
Yen	:	Japanese Yen

CHAPTER I
INTRODUCTION

CHAPTER I INTRODUCTION

1.1 Authority

This report has been prepared in accordance with the "Scope of Work for the Feasibility Study on the Irrigated Agricultural Development Project (Project) in Jesus de Otoro Valley, Intibuca Department in the Republic of Honduras" (hereinafter referred to as the "S/W") agreed upon between the Directorate General of Water Resources (DGWR), Ministry of Natural Resources (MNR) of the Republic of Honduras and the Japan International Cooperation Agency (JICA) on March 19, 1992.

The feasibility study of the Project has been conducted in two phases. The field work of the Phase I was carried out from October to December, 1992 in Honduras and home office work of the same from May to July, 1993 in Japan, as a result of which the Interim Report containing a basic development plan was prepared.

At the commencement of the field survey of the Phase II, which was carried out from July to September in 1993, the Interim Report was submitted, explained to the Government of Honduras, discussed and agreed basically upon between the Government of Honduras (represented by the DGWR) and JICA study team. From September to November in 1993, further study and analysis of survey and investigation results obtained in Honduras were made in Japan, taking into due account the contents discussed with the Government of Honduras, and a development plan was formulated.

This report has been prepared as a comprehensive result of the Feasibility Study on the Project.

1.2 Background of the Study

Agriculture is the biggest sector in Honduras, contributing to 22% of the Gross Domestic Product, 47% of labor force and 80% of export earnings (including banana and coffee). In spite of such a situation, the production of the basic grains such as rice and maize are unstable and still not self-sufficient, and their importation tends to increase every year. The income in the rural area is low and unstable, and income disparity between rural and urban areas have extremely been widening. The Government has been making efforts to increase the production of the main cereals, to increase farmer's income and to raise farmer's living level by improvement of agricultural and rural infrastructure.

The Study Area, Jesus de Otoro Valley in the Department of Intibuca, is located at western part of the central Honduras and blessed with such development potential and natural conditions as topography, climate and water resources. Due to underdeveloped agricultural infrastructure and transport facilities, only rice, maize and field beans (frijoles) have been mainly produced because they can be stored and are less damaged during transportation. It results for the valley to be an important supplying base of the basic grains for the country. The

narrow selection of crops and unstable production bring them low income and large income disparity comparing to other areas. Lately, as national roads connecting to big consuming cities such as Tegucigalpa, San Pedro Sura, etc. have been much improved, there is a growing tendency to introduce cash crops such as tomato, asparagus, onion, grape, etc. In order to make this tendency to fix to the area, and to raise farmer's income, it is most important and urgent to improve the agricultural infrastructure in order to exploit development potentials in the valley.

Under these situation, the Government of Honduras requested the Government of Japan to provide technical assistance for the feasibility study on the Project in December, 1990. In response to the request of the Government of Honduras, the Government of Japan sent a JICA preliminary survey mission to Honduras in April, 1992. After discussion on the implementation of the Study, the Scope of Work for the Study (S/W) and the Minutes of Meeting (M/M) were agreed upon and signed on April 19, 1992.

According to this S/W and M/M, JICA dispatched the Feasibility Study Team (the Team) for the Project to Honduras in October, 1992. The Team submitted the Inception Report to the Government of Honduras for explanation and discussion. The contents of the Inception Report were agreed by the Government and the Minutes of Meeting were signed on October 19, 1992, and the feasibility study started in accordance with the Inception Report. In this report, the results of the feasibility study which was carried out until March,1994 are described.

1.3 Study Area

The Study Area covers Jesus de Otoro Valley (approximately 8,140 ha) in Intibuca Department.

1.4 Objectives and Scope of the Study

According to the S/W agreed upon between Directorate General of Water Resources and JICA on March 19, 1992, the objectives and the scope of the Study are as follows:

1.4.1 Objectives of the Study

The objectives of the Study are,

- To conduct feasibility study in order to formulate the irrigated agricultural development plan, which may include livestock, in Jesus de Otoro Valley, Intibuca Department, and
- To carry out technology transfer to the Honduras counterpart personnel concerned in the course of the Study.

1.4.2 Study Team Members

The Study Team is composed of twelve engineers and experts as presented in Appendix-1.

1.4.3 Scope of the Study

The Study consists of the following two phases, and work plans in each phase are as follows,

(1) Work in Phase I

1) Collection of data and informations on,

(a) Topography (existing topographic maps),
(b) Meteorology (data of 7 meteorological stations),
(c) Hydrology (data of La Gloria Station),
(d) Geology (existing geology maps),
(e) Soil and Land use (existing aerophotos and land use maps),
(f) Land holding and Tenure conditions (data of Census, cadastre),
(g) Irrigation and drainage system,
(h) Farming method and Agricultural production (statistic data, condition of agricultural extension, kinds of crops, farming, activities of authorities concerned),
(i) Agro-economy and Marketing (population, economy, production, finance, agricultural machinery),
(j) Farmer's organization and Supporting services,
(k) Rural infrastructure (roads lists, development plan, condition of water supply, transportation, communication, electrification, health, education),
(l) Construction materials and their cost, and
(m) Environment (organization of authorities concerned, laws and regulations concerned, resident problems, health),

2) Field survey

(a) Hydrology (present condition of main rivers, installing an automatic water gauge in Yucanguare River and 4 staff gauges in Yucanguare River, Naranjo River, Mixcure River and Aro River),
(b) Geology (reconnaissance survey on topography, geology and rocks),
(c) Soils (70 points of auger boring,

25 points of test pitting, chemical and physical analysis on commission),

(d) rural infrastructure (present conditions of roads, water supply),

(e) Agriculture (reconnaissance survey on farming),

(f) Irrigation and drainage (reconnaissance survey on irrigation, operation and maintenance, existing irrigation facilities on commission),

(g) Agro-economy (reconnaissance survey on present conditions, questionnaire survey on commission),

(h) Topography (setting up 26 bench marks, 26 km of center line surveying of rivers on commission),

(i) Environment (reconnaissance survey on present conditions of study area and surrounding mountainous areas).

3) Mapping of 1/5,000 topographic maps including aerial photo-taking, ground survey

4) Formulation of a Basic Development Plan

(2) Work in Phase II

1) Field survey

(a) Meteorology and hydrology (collection of supplementary data of stations, maintenance and collection of data of installed 4 water gauge stations, outlet discharges of the existing irrigation systems),

(b) Geology (reconnaissance survey on proposed main facilities sites, 9 points totally 120 m of boring and standard penetration tests, and laboratory tests of 6 samples from 2 sites on commission),

(c) Soil (75 auger boring and 25 test pitting survey and chemical and physical analysis of 80 samples on commission),

(d) Land use (reconnaissance survey with aerial photo for preparing land use map),

(e) Rural infrastructure (decision and surveying of proposed road routes, decision of locations of agricultural development center

and assembly halls, facilities designing),
(f) Agriculture (collection and analysis of supplementary data and informations, quadrat sampling survey on rice yield),
(g) Irrigation and drainage (reconnaissance survey on the proposed weir sites and canal lines, collection of water management data and data for cost estimation, facilities designing),
(h) Agricultural organization and agro-economy (collection of data of agro-economy, agricultural organization, price of agricultural products and production)
(i) Topography (surveying for 13 bench marks, 11.5 km of main canal line and 5 weir sites on commission),
(j) Environment (collection of data and informations on environmental basic law, organization of authorities concerned, standards on water pollution and chemicals, water quality of Otoro River).

2) Formulation of the irrigated agricultural development plan consisting of:

(a) Irrigation and drainage development plan,
(b) Land use, cropping pattern and farming method,
(c) Rural roads,
(d) Water management,
(e) Agricultural organization and supporting services development plan, and
(f) Others.

3) Implementation schedule of the Project

4) Operation and maintenance plan
5) Estimation of the project cost and benefits
6) Project evaluation (including environmental aspects)
7) Recommendations

CHAPTER II
BACKGROUND

CHAPTER II BACKGROUND

2.1 Geography and Population

2.1.1 Geography

The Republic of Honduras lies in the middle of the Central American isthmus. Its neighbors are Guatemala and El Salvador to the west and Nicaragua to the east. It has a long northern coastline on the Caribbean Sea and a narrow southern outlet to the Pacific Ocean. It has a total land area of 112,00 square kilometers (sq km), corresponding to one thirds of that in Japan, of which approximately 65 % are composed of mountainous and hilly areas. Highlands with the average altitude of 1,000 to 1,500 meters are lying in the central and southern parts of the country. Although Honduras may have some influence of earthquake occurred in the neiboring countries where the pan-pacific volcanic belt is running. Honduras is the only country in Central America that has no possibility of becoming the seismic center due to absence of volcano. The capital of the country is Tegucigalpa, located on the plateau lying in the central and southern part of the country.

2.1.2 Population

Honduras had a population of 4,376,839 in 1988 which had increased from the level of 2,656,948 persons in 1974 at an annual average growth rate of 3.63 % during 1974 and 1988. Population density of 23.7 persons per sq km in 1974 was also increased to 39.0 persons per sq km in 1988. Assuming that the population would be increased at an annual average of 3.6 % during 1988 and 1993, the population in Honduras is estimated to have reached 5.2 million in 1993.

Population of Honduras on the basis of 1974 and 1988 Population Censuses are presented in Table 2.1.1.

2.2 Administrative Divisions

Honduras is administratively divided into 18 departments, including the Bay isles. These departments are further sub-divided into municipalities (municipios) which are composed of several villages (aldeas) and hamlets (caserios). Municipality (Municipio) is the smallest administrative unit and there are 283 municipalities in Honduras.

The governor of each department is appointed by the Interior Minister and the mayor of each municipio is popularly elected.

2.3 National Economy

2.3.1 Gross Domestic Product

Gross Domestic Product (GDP) of Honduras increased from 10,338 million Lempiras in 1989 to 12,540 million Lempiras in 1990 in terms of market prices which showed a nominal growth rate of 21.3%. Taking into consideration the inflation rate, however, the real growth rate was merely 0.08%.

During 1980 and 1985, GDP at 1978 constant prices grew at an annual rate of 1.7%, and during 1985 and 1990, the growth rate averaged at 3.1% per annum.

As indicated in Table 2.3.1, GDP per-capita at 1978 constant prices has decreased from 1,185 Lempiras in 1980 to 1,086 Lempiras in 1990 which clearly indicated that economic growth rate could not keep pace with the population growth rate during the same period.

In terms of 1990 market prices, the agriculture sector had the share of 22.4% in GDP, manufacturing sector had the share of 11.6%, and the commerce sector 11.5%. (See Table 2.3.1)

2.3.2 Balance of Payments

The principal exports in Honduras are banana, coffee, sugar, tobacco, and shrimp and lobster, which are mainly exported to the U.S.A. and neighboring countries in the central america. Of these export items, banana and coffee accounted for more than 60% of the total export amount in 1990. The principal imports are petroleum, chemicals, transport equipment, machinery, and basic manufacturing products.

Import amount in Honduras exceeded export amount every year during 1978 and 1990, showing a chronic trade deficit in this country (see Table 2.3.2). In 1990, Honduras imported good valued at 4,820 million Lempiras and exported good valued at 4,220 million Lempiras with a trade deficit of about 600 million Lempiras. In terms of 1978 constant prices, the growth rate of import amount has had the tendency of decrease, and that of export amount has shown a slight increase during 1978 and 1990. Trade deficit is supplemented by transfers and capital account (financial assistance from bilateral donors and multilateral lending institutions).

2.3.3 Economically Active Population

The economically active population (or labor force) in Honduras increased from 1 million in 1980 to 1.462 million in 1990 at an average annual rate of 3.9%. Agriculture, including livestock, forestry and fishery, is the most important sector in Honduran economy, accounting for 47% of the total labor force in 1990. The share of other sectors in the labor force are 20% in services, 11.8% in manufacturing, 10.1% in commerce and 5.7% in construction. (See Table 2.3.3)

2.4 Agriculture Sector

2.4.1 Outline of Agriculture Sector

Agriculture sector is the mainstay of Honduran economy, accounting for 47% of the total labor force, 22% of GDP, and more than 80% of the export earnings (1990). Activities in the agriculture sector consist of crop production, livestock, forestry and fishery. Crop production dominated the total agricultural output with the share of 59%, followed by livestock production with 25%, and fishery production with 16%. Out of the crop production, banana and coffee accounted for 51% of the total crop output. In 1990, export value of banana and coffee amounted to 890 million (US$180 million) and 1,630 million (US$360 million) Lempiras, respectively. The export value of banana and coffee accounted for 64% of the total export earnings (FOB value). Production value of basic grains (maize, rice and frijoles) accounted for 26% of the total value of crop production.

Honduras has approximately 1.7 million ha of land suitable for crop production, of which 0.8 million ha are presently utilized for crop production and the remaining land are utilized as pasture and forest area.

Growth rate of agricultural production value was as low as 1.85% during 1980 and 1985, however, the same was improved to 3.5% during 1985 and 1990 (see Table 2.4.1).

2.4.2 Crop Production and Food Balance

Although production of basic grains has had the tendency of increase in the longer term, annual fluctuation of production has been very large. Particularly, unstable production of rice has been reflected in the fact that the area harvested differed year by year (for instance, 13,500 ha in 1988-1989 and 21,800 ha in 1983-1984), which is considered to be due to weather conditions. Food balance analysis of basic grains indicated that maize, rice and frijoles were in short supply in 1991 and 1993, and that the shortage of maize and rice would continue from 1994 onwards. Due to shortage of basic grains production, Honduras has bee net importer of these grains. In 1991, the country imported 75,277 t of maize and 32,814 t of rice.

2.5 Farm Size and Farmer Organizations

2.5.1 Farm Size

Based on 1974 Agricultural Census data, there were 195,341 farms in Honduras with the total land holding of 2,629,859 ha, averaging 13.46 ha per farm. It should be noted, however, that small land holders with less than 5 ha accounted for 63.9% in the number of farms, occupying only 9% of the total land area. Medium land holders with 5 to 50 ha accounted for 32.1% in the number of farms, occupying 35.4% of the total land area. Large land holders with more than 50 ha accounted for 4% in the number of farms, occupying 55.5% of the total land area.

2.5.2 Farmer Organizations

In order to improve the uneven distribution of land ownership as described above, Honduran government has performed, through INA (National Agrarian Institute), the land acquisition and distribution program based on the Land Reform Law No. 170. The beneficiaries of the same were landless farmers and small land holders with less than 5 ha. As of 1991, 55,984 families have been settled in the locations within the country, forming 2,650 farmer groups. A total of 364,048 ha of land have been adjudicated to these groups.

INA has been providing, in collaboration with other government agencies such as RRNN and BANADESA, financial and technical assistance to the land reform beneficiaries. Under the Land Reform program, establishment of cooperatives or associative enterprises (EA) among these beneficiaries has been promoted in order to increase the agricultural production and improve the living conditions of the beneficiaries.

Technical and financial assistance has also been provided to small land holders with less than 5 ha. These small land holders formed Agricultural Committees to receive technical and financial assistance from RRNN and BANADESA.

In addition to the above, there are other forms of farmer organizations such as Women Committees, consisting of wives of Farmer Groups members, and Youth Clubs consisting of young generations of farmers. Government agencies and other institutions are providing training courses such as literacy education, guidance of home garden, nutrition education, etc. for these groups.

2.6 Agricultural Policy

Strategic guidelines for agriculture sector have been indicated in "Strategy for 1990-1994 Integral Development" prepared by SECPLAN, which are summarized as follows.

(a) To strengthen, modernize and speed-up production and export of traditional crops

(b) To liberalize the domestic and foreign basic grains trade and transfer marketing activities to the private sector

(c) To encourage diversification in non-traditional export products

(d) To strategically orient the development of agricultural infrastructure

(e) To speed up the process of land documentation procedure in the land reform sector

(f) To encourage the adoption of suitable agricultural technologies for small farmers

(g) To strengthen the agricultural sector's financial system

Following the agricultural policy as mentioned above, "The Law for the Modernization and Development of the Agricultural Sector" (Decree No. 31-92) was established in April 1992. This law made revisions to several laws and regulations in the agriculture sector including the Land Reform Law No. 170 in 1975. Main objectives of this law are to revise the provisions, among other things, on land ownership, agricultural price setting, and agricultural credit policy (see details in ANNEX E).

Table 2.1.1 HONDURAS: POPULATION STATISTICS 1974-1988

Department	Area (Km2)	1974		1988		Annual Increase (%)
		Population	Density	Population	Density	
1 Atlantida	4,251.2	148,285	34.9	237,180	55.8	3.41
2 Colon	8,874.8	77,750	8.8	146,224	16.5	4.62
3 Comayagua	5,196.4	136,619	26.3	238,790	46.0	4.07
4 Copan	3,203.0	151,859	47.4	218,864	68.3	2.65
5 Cortes	3,954.0	369,616	93.5	644,807	163.1	4.05
6 Choulteca	4,211.0	193,336	45.9	293,260	69.6	3.02
7 El Paraiso	7,218.1	140,793	19.5	255,400	35.4	4.35
8 Francisco Morazan	7,946.2	453,597	57.1	797,611	100.4	4.11
9 Gracias a dios	16,630.0	20,738	1.2	34,159	2.1	3.63
10 Intibuca	3,072.2	81,815	26.6	123,512	40.2	2.99
11 Islas de la Bahia	260.6	13,194	50.6	21,553	82.7	3.57
12 La Paz	2,330.6	66,046	28.3	105,996	45.5	3.44
13 Lempira	4,289.7	127,782	29.8	175,450	40.9	2.29
14 Ocotepeque	1,680.2	51,038	30.4	74,286	44.2	2.72
15 Olancho	24,350.9	151,436	6.2	282,018	11.6	4.54
16 Santa Barbara	5,115.3	186,106	36.4	277,995	54.3	2.91
17 Valle	1,564.6	91,901	58.7	119,889	76.6	1.92
18 Yoro	7,939.2	195,037	24.6	329,845	41.5	3.82
Total:	112,088.0	2,656,948	23.7	4,376,839	39.0	3.63

Source: Censo Nacional de Poblacion y Vivienda 1988

Table2.3.1 GROSS DOMESTIC PRODUCT PER CAPITA

	Unit	1980	1985	1990
1 GDP at market prices	Million Lempiras	5,132	7,279	12,540
2 GDP at 1978 prices	Million Lempiras	4,066	4,428	5,165
3 Annual increase	per cent (%)	2.6	1.7	3.1
4 Population	Thousand	3,431	4,041	4,758
5 Per Capita GDP at current prices	Lempiras	1,496	1,801	2,636
6 Per Capita GDP at 1978 prices	Lempiras	1,185	1,096	1,086

Source: Cuentas Nacionales de Honduras 1978-1990

Note: GDP = Gross Domestic Product

Table 2.3.2 HONDURAS: GROSS DOMESTIC PRODUCT (GDP)

Activity	1980		1985		1990	
	Million Lempiras	Distribution (%)	Million Lempiras	Distribution (%)	Million Lempiras	Distribution (%)
1 Agriculture, forestry and fishery	1,087	23.7	1,407	21.9	2,503	22.4
2 Mining and quarrying	96	2.1	139	2.2	194	1.7
3 Manufacturing industry	687	15.0	935	14.5	1,823	16.3
4 Electricity, gas and water	64	1.4	113	1.8	353	3.2
5 Construction	270	5.9	356	5.5	574	5.1
6 Commerce	730	15.9	854	13.3	1,289	11.6
7 Transport, storage and comunications	313	6.8	408	6.3	703	6.3
8 Finance and security	297	6.5	443	6.9	826	7.4
9 Dwelling	250	5.4	504	7.8	790	7.1
10 Public administration and defence	346	7.5	584	9.1	814	7.3
11 Services	453	9.9	695	10.8	1,290	11.6
GDP at factor costs	4,593	100.0	6,438	100.0	11,159	100.0
Indirect taxes	539		841		1,381	
GDP at market prices	5,132		7,279		12,540	

Source: Cuentas Nacionales de Honduras 1978-1990

Table 2.3.3 HONDURAS: ECONOMICALLY ACTIVE POPULATION

Unit: Thousand

Economic Activity	1980	Distri-bution (%)	1985	Distri-bution (%)	1990	Distri-bution (%)
1 Agriculture, forestry and fishery	555	55.5	618	51.4	688	47.1
2 Mining and quarrying	4	0.4	4	0.3	4	0.3
3 Manufacturing industry	115	11.5	141	11.7	172	11.8
4 Electricity, gas and water	4	0.4	6	0.5	9	0.6
5 Construction	40	4.0	57	4.7	83	5.7
6 Commerce	87	8.7	113	9.4	148	10.1
7 Transport, storage and comunications	28	2.8	34	2.8	41	2.8
8 Finance and security Dwelling	13	1.3	18	1.5	26	1.8
9 Services	154	15.4	212	17.6	291	19.9
Total	1,000	100.0	1,203	100.0	1,462	100.0

Source: Cuentas Nacionales de Honduras 1978-1990

Table 2.4.1 HONDURAS: PRODUCTION OF BASIC GRAINS (1980-1991)

Year	Maize		Frijol		Paddy		Sorghum	
	Area ('000 ha)	Production ('000 ton)	Area ('000 ha)	Production ('000 ton)	Area ('000 ha)	Production ('000 ton)	Area ('000 ha)	Production ('000 ton)
1980-81	339.6	387.8	68.3	35.9	19.7	35.9	61.9	52.2
1981-82	339.0	481.1	76.5	42.2	21.2	36.7	58.4	58.0
1982-83	272.1	366.1	51.1	30.7	15.0	21.9	25.3	32.3
1983-84	308.8	458.6	50.7	30.6	21.8	46.3	51.1	46.6
1984-85	368.8	507.2	58.9	32.9	17.9	48.6	59.6	52.4
1985-86	288.8	423.5	67.6	38.7	14.7	45.7	13.8	12.2
1986-87	345.7	483.5	74.8	40.0	13.7	34.3	43.4	19.1
1987-88	343.3	522.6	66.2	36.0	20.8	59.3	27.1	31.1
1988-89	333.9	440.9	78.9	52.4	13.5	31.9	59.8	53.6
1989-90	350.9	510.1	81.2	57.1	16.9	46.7	65.3	61.8
1990-91	367.4	558.5	92.8	73.7	17.6	44.9	78.8	81.2
1991-92	436.0	583.5	155.0	109.9	21.2	55.7	83.0	93.2

Source: Compendio Estadistico Agropecuario, 1992, RRNN

Table 2.4.2 HONDURAS: DEMAND AND SUPPLY OF BASIC GRAINS (1991-2002)

	Production 1/			Consumption					Deficit or Excess ('000ton)
	Gross Production ('000ton)	Seeds/ Loss ('000ton)	Net Production ('000ton)	Population ('000)	Per capita Consumpt. (ton)	Human Consumpt. ('000ton)	Animal Consumpt. ('000ton)	Total Consumpt. ('000ton)	
Rice 2/									
1991	85.7	17.1	44.6	4,853	0.019	92.2	0.5	92.7	-48.1
1993	89.6	17.9	46.6	5,763	0.020	115.0	0.6	115.6	-69.0
1998	100.2	20.0	52.1	6,681	0.021	140.0	0.7	140.7	-88.6
2003	112.0	22.4	58.3	7,559	0.022	166.3	0.8	167.1	-108.8
Maize									
1991	583.5	75.9	507.6	4,853	0.130	630.8	36.0	666.8	-159.2
1993	627.6	81.6	546.0	5,763	0.137	786.7	44.8	831.6	-285.5
1998	753.0	97.9	655.1	6,681	0.143	957.6	54.6	1012.2	-357.1
2003	903.4	117.4	786.0	7,559	0.150	1137.6	64.8	1202.5	-416.5
Frijoles									
1991	109.9	25.3	84.6	4,853	0.022	106.8	0.00	106.8	-22.1
1993	126.9	29.2	97.7	5,763	0.023	133.1	0.00	133.1	-35.4
1998	181.7	41.8	139.9	6,681	0.024	162.1	0.00	162.1	-22.1
2003	260.3	59.9	200.4	7,559	0.025	192.5	0.00	192.5	7.9
Sorghum									
1991	93.2	7.3	85.9	4,853	0.003	12.6	15.3	27.9	58.0
1993	101.8	11.2	90.6	5,763	0.003	15.7	19.1	34.9	55.8
1998	127.1	14.0	113.1	6,681	0.003	19.2	23.3	42.4	70.7
2003	158.6	17.4	141.2	7,559	0.003	22.8	27.6	50.4	90.8

Source: 1. Compendio Estadistico Agropecuario, 1992
2. Plan Estrategico para la Produccion de Granos Basicos 1991-92 y 1992-93

Note: 1/ Annual increase of basic grains production:
- Rice at 2.26%; Maize at 3.71%; Frijoles at 7.45%; Sorghum at 4.53%

2/ Rice weight = Paddy weight x 0.8 (losses) x 0.65 (processing)

Table 2.5.1 DISTRIBUTION OF FARM LAND (1974)

Category of Farm Size	Honduras		Intibuca		Jesus de Otoro	
	Farm (No.)	Area (ha)	Farm (No.)	Area (ha)	Farm (No.)	Area (ha)
Less than 1 ha	33,771	21,542	1,489	986	236	148
1 - 2 ha	38,650	53,648	2,153	3,036	233	325
2 - 3 ha	28,703	69,880	1,873	4,602	162	395
3 - 4 ha	11,659	40,790	800	2,806	59	206
4 - 5 ha	11,998	53,133	874	3,852	54	243
0-5 ha:	124,781	238,993	7,189	15,282	744	1,317
Distribution (%)	63.9	9.1	62.4	13.9	70.3	12.0
5 - 10 ha	28,264	201,274	2,076	14,619	125	870
10 - 20 ha	19,220	268,145	1,217	16,795	84	1,161
20 - 50 ha	15,170	461,216	757	22,612	65	1,857
5-50ha:	62,654	930,635	4,050	54,026	274	3,888
Distribution (%)	32.1	35.4	35.2	49.1	25.9	35.4
50 - 100 ha	4,433	301,228	182	11,883	28	1,831
100 - 200 ha	1,971	266,697	52	7,069	6	856
200 - 500 ha	1,057	313,207	34	10,190	4	1,328
500 - 1,000 ha	276	183,769	10	6,628	3	1,763
50-1000ha:	7,737	1,064,901	278	35,770	41	5,778
Distribution (%)	4.0	40.5	2.4	32.5	3.9	52.6
1,000 - 2,500 ha	129	185,980	4	4,925	0	0
2,500 ha over	40	209,350	0	0	0	0
More than 1000ha:	169	395,330	4	4,925	0	0
Distribution (%)	0.09	15.0	0.03	4.5	0	0
Total:	195,341	2,629,859	11,521	110,003	1,059	10,983
Average Farm Size (ha):		13.46		9.55		10.37

Source: Censo Nacional Agropecuario 1974

Table 2.5.2 HONDURAS: DISTRIBUTED LAND FOR FARMER GROUPS (1991)

Region	Number of Groups	Initial Members	Actual Members	Adjudicated Area (ha)	Cultivable Area (ha)
1 Zona Sur (Choulteca)	330	10,831	5,173	40,182.0	21,843.5
2 Zona Norte (San Pedro Sula)	882	26,289	22,262	112,538.4	85,117.9
3 Zona Litoral Atlantico (La Ceiba)	190	3,079	2,103	13,086.7	11,233.4
4 Zona Occidente (Sta. Rosa de Copan)	341	8,668	7,146	25,852.0	19,932.4
5 Zona Nor Oriente (Olancho)	214	3,420	2,240	15,307.3	9,623.2
6 Zona Centro Oriental (Danli)	147	2,831	2,004	19,624.5	10,960.4
7 Zona Centro Occidental (Comayagua)	26	7,042	5,261	46,997.3	29,696.7
8 Zona Aguan (Sinaloa)	178	7,235	7,881	100,059.2	95,486.2
9 Zona Francisco Morazan (Tegucigalpa)	107	2,359	1,914	11,662.8	5,066.0
Total	2,415	71,754	55,984	385,310.1	288,959.6

Source: INA, Seccion de Informacion

CHAPTER III
PRESENT CONDITIONS OF THE STUDY AREA

CHAPTER III PRESENT CONDITIONS OF THE STUDY AREA

3.1 Location

The Study Area is located in the western-central part of Honduras, 95 km towards the northwestern part of the capital city, Tegucigalpa, and administratively belongs to Jesús de Otoro municipality, in Intibucá Department.

Concretely, the Study Area is located in the Grande de Otoro River Basin, which flows towards the north in the eastern region of the Intibucá Province, inside a valley, at an elevation of 600 meters above the sea level. Its area is about 7,500 ha. and extend to both sides of the Grande de Otoro River, from the point of the crossing of the main road which joins Siguatepeque and La Esperanza (old road) with the Grande de Otoro River, towards the north approximately 16.5 km up to the narrow part of the river. This valley extends 5 to 8 km wide in east-west direction, and 16 km long in north-south direction.

3.2 Natural Condition

3.2.1 Topography

Topography of the Study Area is a valley surrounded with mountains of about two thousand meter high such as Cerro Verde, San Juanillo on the east, Verde, Mixcure on the west and Pacayal on the south. The valley is broadly divided into river terrace hilly regions and mountainous area. The study area along the river is occupied by river terrace, hilly regions are a complex mixture of gently to rolling slopes and flat land. The outskirts of valley over 700 meter altitude slants steeply and sift to the mountainous area. The altitude varies from about EL 620m in the southern end part of the study area and EL 520m in the northern end. Average ground slope is rather steep of about 1/130 varying from 1/15 to 1/400. Most of the agricultural land concentrate in the river terraces and some part of hilly regions that have good water carriage from tributaries of Rio Grande de Otoro. The hilly region and up land is using as field in rainy season, grass land and pasture. The natural vegetation in the neighboring mountains of the valley is evergreen forest with individual tree reaching a height of approximately 10 - 15 m and some dense stands. Main river in the area except the Rio Grande de Otoro is the Rio Yucanguare, which is one of the major seven(7) tributaries of Rio Grande de Otoro. A large number of natural streams and channels provide a fairly good system of surface drainage and most part of the study area are free from drainage problem. However, poor drainage area is very small part of study area on right bank of Rio Grande de Otoro. The Rio Grande de Otoro runs through the valley from the south to north flow into Rio Ulua and flow in the Caribbean sea.

3.2.2 Meteorology

General climate in Honduras shows different phases at the inland area and the coastal zone of Caribbean Sea due to the mountain range which lies lengthwise and crosswise in the whole nation with the peak altitude of around 2,000 m. In the coastal zone,

rainfalls occur through the year owing mainly to the trade wind from the northeast and the Nombre de Dios mountains situated just inland from the shore. Tela and La Ceiba located in the coastal zone get more than 3,000 mm of rainfall. Moreover, coastal zone is affected by the hurricanes which generate in Caribbean Sea from August till November. The central, southern and western parts of Honduras have a rainy season, from May through October or November, when prevailing winds bring moistened clouds to inland from the coast. From December till April, dry season which monthly rainfall is less than 100 mm comes around due to the shift of prevailing winds.

Intibuca Department where the Study is included is located in the central part of Honduras. Climatic factors in the Study Area, such as rainfall and sunshine hours, are governed by the dynamics of those prevailing winds. The shift of prevailing winds carries seasonal variation of rainfall amount and generates the climatic condition such as rainy and dry seasons in the Study Area.

Meteorological data observation in and around the Study Area is being carried out by the Directorate General of Water Resources (DGWR), National Electric Power Company (ENEE), and National Meteorological Services. Observation system of each meteorological station can be classified into types of rainfall gauge station, observation station of a part of meteorological items, and synthetic meteorological station. La Gloria Meteorological Station governed by the DGWR is situated at the central part of the Study Area, observing climatic items such as rainfall, temperature, relative humidity and evaporation. Moreover, seven meteorological stations can be selected as the major observatories related to the Study Area.

According to the observed records at La Gloria station, the Study Area shows two distinctive climatic seasons. One is the rainy season from May to October which occurs more than 90% of annual rainfall and the other is the dry season from November to April. Mean annual rainfall is 1,012 mm with mean annual evaporation of 1,951 mm. General climatic conditions in the Study Area represented by La Gloria station are as follows:

Month	Temperature C	Relative humidity %	Evaporation mm	Rainfall mm
JAN	23.2	78	147.9	7.3
FEB	24.0	75	168.5	6.6
MAR	26.3	70	234.0	6.2
APR	27.4	69	229.5	35.5
MAY	27.4	71	206.0	111.5
JUN	26.0	78	147.1	185.6
JUL	25.4	78	158.9	144.1
AUG	25.7	78	155.3	161.5
SEP	25.4	79	141.7	213.8
OC	24.5	81	126.0	100.5
NOV	23.7	80	115.0	25.6
DEC	23.3	79	121.6	12.8
Annual	125.2	76	1,951.5	1,012.0

The Rio Grande de Otoreo basin can be divided into six sub-areas by the Thiessen Polygon with six rainfall observatories related

to the objective river basin and mean annual rainfall is estimated at 1,323 mm using the areal ratio of the Polygon.

Based on the said Thiessen Polygon, climatic condition in the proposed development area formulated through the Study takes place in the circle of influence of La Gloria meteorological observatory. Therefore, the data of La Gloria observatory will be utilized as the climatic factors related to the development plans including irrigation schemes.

3.2.3 Hydrology

Rio Grande de Otoro which is the major river in the Study Area locates between the confluence of Rio Zazagua and Rio Puringla in the upper reach and the junction of Rio Ulua in the lower reach. The river flows down from south to north through the Otoro plain with basin area of 733 sq km and 41 km in river length. Seven major tributaries join to the river and those tributaries have 170 sq km to 30 sq km of basin areas. The total basin area which composes from the junction of Rio Ulua to the uppermost of the basin is 1,484 sq km.

Measurement of water levels and discharges of Rio Grande de Otoro is being carried out by the DGRH at La Gloria from 1967 up to date. No measurement is executed in the tributaries and upper and lower reaches of Rio Grande de Otoro except La Gloria. General description of La Gloria gauging station, such as basin area and mean annual run-off volume, are as follows:

Gauging Station	Drainage Area (sq km)	Mean Annual Areal Rainfall (mm)	Mean Annual Run-off (MCM)	Run-off Coeff.
La Gloria	841.4	1,417.5	569.3	0.48

Mean monthly run-off volume at La Gloria gauging station is shown below. Coincidentally with the monthly rainfall distribution, the peak monthly discharge of Rio Grande de Otoro takes place among in August, September and October, however, occurrence in September is noticeable. Annual run-off volume fluctuates from 188 MCM to 1,093 MCM during the observed period of past 23 years. Also, annual-basis run-off coefficients vary from 0.4 to 0.7 depending on the total volume of annual rainfall.

UNIT:MCM

JAN FEB	MAR APR	MAY JUN	JUL AUG	SEP OCT	NOV DEC	ANNUAL
21.0 15.4	14.0 12.9	24.4 78.1	55.0 69.3	109.6 92.7	46.9 30.0	569.3

Annual momentary maximum discharge (flood discharge) has been recorded at 999 m^3/s in 1968 and the minimum is 1.20 m^3/s in 1971. These values are correspond to return period of 30-year and 50-year, respectively.

Based on the discharge measurement records at La Gloria, run-off on the monthly-basis and its specific discharges can be expressed as follows for the hydrological year of average, high-water and low-water. Those hydrological years lay down; the high-water year means that the total annual rainfall is equivalent to the exceedance probability of 5-year, and the low-water year is the year that the total annual rainfall is equivalent to the non-exceedance probability of 5-year. The average year situates that the total annual rainfall is equivalent to average values among the observed periods.

Month	Monthly Discharge (MCM)			Specific Discharge ($m^3/s/km^2$)		
	A	H	L	A	H	L
JAN	21.04	19.81	16.27	0.0093	0.0088	0.0072
FEB	15.42	13.88	11.26	0.0075	0.0068	0.0055
MAR	13.96	14.11	10.41	0.0061	0.0063	0.0046
APR	12.88	9.78	11.53	0.0059	0.0045	0.0053
MAY	24.42	32.26	21.67	0.0108	0.0143	0.0096
JUN	78.10	116.38	54.04	0.0358	0.0534	0.0248
JUL	55.01	105.62	47.46	0.0244	0.0469	0.0211
AUG	69.34	101.24	85.10	0.0307	0.0449	0.0289
SEP	109.56	181.87	92.60	0.0502	0.0834	0.0425
OCT	92.68	126.10	93.68	0.0411	0.0560	0.0416
NOV	46.86	57.09	49.67	0.0214	0.0262	0.0228
DEC	30.03	35.11	40.42	0.0133	0.0156	0.0179
ANNUAL	569.30	813.20	514.12	0.0215	0.0306	0.0194

A: Average year H: High-water year L: Low-water year

Taking the average annual rainfall of 1,323 mm related to the Rio Grande de Otoro basin of 1,484 km^2 and average annual run-off coefficient of 0.48 at La Gloria station into account, basin run-off on an average year is anticipated at 940 MCM in basin as a whole.

Existing farmlands and arable lands situated in the basins of Rio Grande de Otoro and the tributaries are developed below 700 m in elevation. Therefore, the areas located over 700 m in elevation can be considered as the cultivated area of water resources. From the calculation results of specific discharge at La Gloria and the cultivated area of water resources of the river basins, following is the available water volume to be utilized in each river basin;

Rio	Cultivated area of water resources km²	Average year MCM	High-water year MCM	Low-water year MCM
G. DE OTORO	807.4	546.49	780.34	493.35
YUCANGUARE	159.2	107.70	153.86	97.28
NARANJO	27.0	18.27	26.10	16.50
MIXCURE	22.5	15.22	21.75	13.75
SIRIMA	40.3	27.27	38.95	24.62
SICAGUARA	50.5	34.16	48.81	30.86
CUMES	27.5	18.61	26.58	16.80
ARO	24.9	16.85	24.07	15.21
TOTAL	1,159.3	784.57	1,120.06	708.37

From the above table, available water resources to be developed in the study area can be estimated at about 84 percent (785MCM) of annual basin run-off on an hydrological average year. When the annual run-off is divided into the rainy and dry seasons as shown in the table below, however, run-off during the rainy season is occupied over 75 percent of the total annual run-off. Moreover, about 70 percent of the run-off during the dry season (around 190 MCM) discharges from the Rio Grande de Otoro.

UNIT:MCM

Rio	Average Year		High-water year		Low-water year	
	Dry	Rainy	Dry	Rainy	Dry	Rainy
G. de Otoro	134.57	411.92	143.73	636.21	133.92	359.43
Tributaries	58.63	179.47	62.67	277.45	58.37	156.65
Total	193.20	591.39	206.40	913.66	192.29	516.08

As the river run-off analysis for the nine proposed weir sites in the six rivers (three sites in the Rio Grande de Otoro, two sites in the Rio Yucanguare, Rio Naranjo, Rio Mixcure, Rio Cumes and Rio Aro), propriety of specific discharge method by the run-off records of La Gloria is confirmed taking the verified results of run-off between tributaries and La Gloria into account. With these, river run-off at the proposed weir sites is estimated by the specific discharge of La Gloria gauging station. Mean monthly run-off at the each proposed weir site can be summarized as follows;

UNIT : MCM

	Otoro			Yucanguare		Naranjo	Mixcure	Cumes	Aro
Month	upper	mid.	lower	upper	lower				
JAN	20.81	21.05	24.01	3.29	4.06	0.69	0.61	0.51	0.57
FEB	15.25	15.43	17.60	2.41	2.97	0.50	0.44	0.37	0.42
MAR	13.81	13.97	15.93	2.19	2.69	0.46	0.40	0.34	0.38
APR	12.74	12.89	14.70	2.02	2.48	0.42	0.37	0.31	0.35
MAY	24.15	24.43	27.87	3.82	4.71	0.80	0.70	0.59	0.66
JUN	77.24	78.15	89.14	12.23	15.06	2.55	2.25	1.88	2.13
JUL	54.40	55.04	62.78	8.61	10.61	1.80	1.58	1.33	1.50
AUG	68.57	69.38	79.14	10.86	12.37	2.27	2.00	1.67	1.89
SEP	108.35	109.63	125.04	17.15	21.13	3.58	3.15	2.64	2.98
OCT	91.66	92.74	105.78	14.51	17.87	3.03	2.67	2.24	2.52
NOV	46.34	46.89	53.48	7.34	9.04	1.53	1.35	1.13	1.28
DEC	29.70	30.05	34.27	4.70	5.79	0.98	0.86	0.72	0.82
Ann.	563.02	569.65	649.74	89.14	109.79	18.61	16.38	13.74	15.50

3.2.4 Geology and Soil Mechanics Condition

(1) Geology

The Study Area is tectonicaly located in the western edge of the Caribbean Plate. Most of the valley in this area were created by intense down block faulting in late tertiary period. Intense volcanism occurred during tertiary times which deposited a thick sequence of extruded volcanic ash and similar volcanic products which were laid in solid surfaces and some in water. This sequence of tertiary strata is known in Honduras as the Padre Miguel Group (Tpm).

All the Study Area is covered with sedimentary strata of quaternary period. This alluvial deposit strata include clay sand, gravel, cobbles, partially volcanic ash but generally consist of alternation of strata. Majority of the study area is extended over alluvial deposit including gravel terraces, flood plains and alluvium. Alluvial sediments have been deposited around the rivers and streams. Thickness of alluvium is heavy including lots of cobbles and sandy gravel layer. Alluvial conglomeratic and associated sedimentary strata produced as a result of intense erosion and sedimentation is known as the Gracias formation.

Many erosion cliff and outcrop exist along the Rio Grande de Otoro which runs through the valley. Generally, strike of stratum is N 15 - 20 W, dip of stratum is gentle slope approximately 15 - 25 degrees. Main rock types are as following.

1) Volcanic rocks consisting of pyroclastic rocks of the rhyolite
2) Andesite
3) Sedimentary rocks are derived from the volcanic rocks and flow of rhyolite

4) Basalt
5) Biotite
6) Plagioclasa
7) Sanidine
8) Quartz

Geological map of the Study Area is shown in Fig 3.2.1.

(2) Soil Mechanic Condition

Nine (9) core drilling tests, two (2) embankment material tests and two (2) river material tests for concrete aggregates have been carried out in the Study Area.

Core drilling tests have been carried out with standard penetration test at proposed left bank weir site on the Rio Grande de Otoro and proposed main structure site on left bank main irrigation canal. The result of tests are as shown in ANNEX C. Thickness of alluvial deposit is heavy every site of core drilling test. No bedrock was found less than 15 m deep in wholly place of core drilling test. The overburden is composed mainly coarse sand including gravel, fine sand, silty sand or thin clay layer including volcanic ash and tuff. The deeper part of the overburden is composed fine sand and contain more volcanic ash.

All of the N value is 50 or more and bearing layer of the structure, from ground surface to 5 m deep is very dense which is considered to be suitable for the foundation. Compaction tests for embankment material of main irrigation canal were carried out in use of two (2) samples from large excavation site. According to the compaction and direct shearing test results, the embankment materials are conceived as the potential materials for embankment except including lots of gravel and cobble stones.

The concrete aggregate test were carried out in use of the sample from upper reach of the Rio Grande de Otoro weir site. According to the laboratory test results, the river materials are conceived to be good materials for concrete aggregate. However, there is need to adjust grain distribution, in case of use.

3.2.5 Soils

(1) Results of Laboratorial Analysis

Analytical results obtained for physical properties, three phase distribution and chemical properties of soil samples were shown in Tables 1.1.4, 1.1.5 and 1.1.6 in Annex B respectively.

1) Physical properties

Apparent specific gravity of the soils occurring in "Valle de Otoro" is around 1.5 with the exception of ones derived from alluvial material. It is assumed, therefore, these soils aren't influenced with volcanic ash because that volcanic ash soil has apparent specific gravity less than 1.0. In the case of alluvial soils, the value lies in the range between 1.3 and 1.1, but it is not less than 1.0. Accordingly, alluvial soils also seems to be not influenced with volcanic ash.

The values derived from pH-moisture curve that are concerned to water retention, water supply and drainage of soil vary considerably with unit of soil. In general, Both field capacity and effective field capacity of soils in which clay accumulates in sub-surface layer are high. Even if sub-surface layer is equally rich in clay content, however, there are some cases in which the values of those capacities differ from unit of soil to unit of soil. Such difference may be derived from divergence in type of clay mineral. Namely, the values of field capacity and effective field capacity are low in the case that sub-surface layer is rich in kaolinites or mica clay minerals and are, conversely, high in the case that sub-surface layer is rich in montmorillonite. In almost of alluvial soils, texture of sub-surface soil is sandy and accumulation of clay material in sub-surface doesn't occur. For this reason, the values of those capacities aren't so high.

When the effectiveness of irrigation is estimated, the values of field capacity and effective field capacity become highly important criterions. For the instance that those capacities are both high, as water can be preserved in soil for long term when irrigation is put into practice, it is favorable to utilize the land as paddy field. In the case that the capacities are too high, excessive water lingers in soil. Because of it, when the land is used as upland field, concurrent practice of irrigation and drainage is indispensable. In alluvial soils, as irrigation practice provides

adequate supply of water, high effectiveness of irrigation on production increase of rice and upland field crops is expected.

2) Chemical properties

As a rule the soils occurring in "Valle de Otoro" present slightly acidic to weakly acidic reaction and merely contain less amount of exchangeable sodium. For this reason, even if the soils are put under irrigation, there is not any fear that the soils will be alkalinized. Cation exchange capacity (CEC) that is an important criterion concerning to nutrient retention of the soil is relatively high on the sub-surface soil rich in clay fraction. However, the values of cation exchange capacity of sub-surface soils vary with the soil unit. Such evidence may be brought with the different in clay mineral types. In general, kaolinites or mica clay minerals exist dominantly in sub-surface soils having low CEC value while montmorillnitic clay minerals distribute predominantly in sub-surface soils having high CEC value. In alluvial soils, as clay materials scarcely accumulate in sub-surface layer, generally, the CEC values are approximately equal and medium between surface layer and sub-surface one. The texture of the sub-surface layer of alluvial soils is usually sandy. Therefore, in these soils, the CEC value in sub layer is lower than one in surface layer. The values of phosphorus retention are, generally, very low in every soils. This fact proves that the soil derived from volcanic ash scarcely occurs.

(2) Soil Classification and Distribution

1) Characteristics of soil units

The soils occurring in the study area were classified into fifteen units (units on the map: series) on the basis of the information obtained from prior investigation of collected data, field survey and laboratorial analysis. Characteristics of each soil unit are summarized in Table 3.2.1. Further detailed description is given in Paragraph 1.1.4 in Annex B.

2) Distribution of soil units

(a) Map of soil units

Distribution of the above-mentioned soil units is shown in

Figure 3.2.2. Further detailed drawing and description are shown in Figure 1.1.2 and Table 1.1.7, respectively, in Annex B.

(b) Soil Taxonomy

At present, the soils occurring in Honduras C.A. are classified into six groups of Fluvisol, Rendzina, Cambisol, Andosol, Luvisol and Acrisol on the basis of FAO's classification standard while ones are classified into six orders of Entisol, Ultisol, Alfisol, Inceptisol, Oxisol and Molisol on the basis of Soil Taxonomy. The soils distributing in Intivuca County are classified into four groups of Rendzina, Canbisol, Andosol and Luvisol on the basis of the former standard and are classified into four orders of Entisol, Alfisol, Oxisol and Molisol on the basis of Soil Taxonomy. However, there is no information concerning to the classification of the soils found in "Valle de Otoro". The soils described above are classified on the basis of Soil taxonomy. The results obtained are shown in Table 1.1.8 in Annex B.

(3) Land Classification

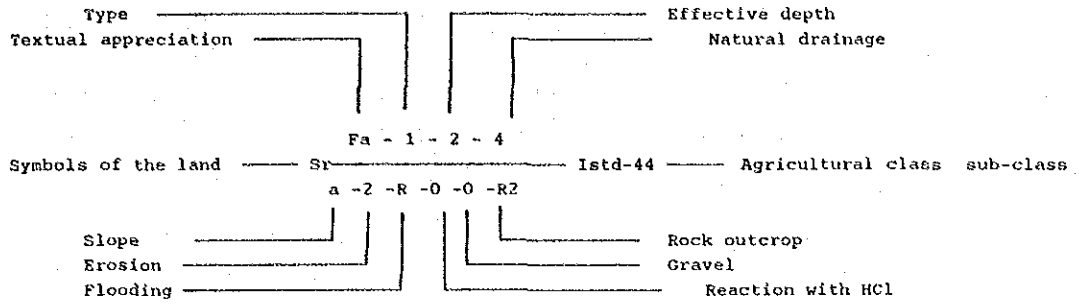
1) Classification standard

Land classification of the study area by use capability was made on the basis of the Manual No.210 for soil conservation service, USDA, this time.

2) Indication of land classification

Use capability of land in the study area was expressed by using the formula with symbols as given below. The detailed description is given in Paragraph 1.2.2 in Annex B.

The formula for use capability of land



3) The result of land classification

The result obtained by the investigation of the information from field survey with above-mentioned criterion of land classification was shown in Table 3.2.5.b. The detailed indication was given in Table 1.2.1 in Annex B.

According to the result obtained from land classification based on use capability, the land in the Valley de Otoro may be divided into nine zones and evaluated on the basis of soil unit every zone as follows:

The zones rated highest: Most alluvial soil zones.
The zones rated high: A part of alluvial soil zones.
The zones rated slightly high: A part of SanMiguel soil zone and El Pital soil zone.
The zones rated intermediately: Las Lomitas, San Lorenzo-Santo Domingo, Agua Blanca and Arrozales soil zones.
The zones rated slightly low: Maye, Comontan, El Paraiso Guayabal, Finca Morales and El Porvenir soil zones.
The zones rated low: El Cipres-Guayaman and Otoro soil zones.
The zones rated lowest: San Francisco-Santo Domingo soil zone and a part of San Miguel soil zone.

3.3 Social Conditions

3.3.1 Administrative Division

The Study Area is located in Jesus de Otoro Municipality of Intibuca Department. Jesus de Otoro Municipality consists of Municipal town (cabecera municipal), which is the center for

political and economic activities, and rural areas. In the execution of the 1988 Population Census, Directorate General of Statistics and Census divided the municipality into six aldeas: i.e. (1) Jesus de Otoro, (2) Coclan, (3) Junquillo, (4) San Antonio, (5) San Jeronimo and (6) San Rafael. A large part of Jesus de Otoro valley is included in Aldea Jesus de Otoro and some parts are included in Aldeas Coclan and San Rafael.

Municipal town is political and economic center of the municipality, where municipal office, branch offices of several government agencies, branch offices of banks, stores, rice mills, public market, etc are located.

3.3.2 Population

(1) Population Trend of Jesus de Otoro Municipality

Based on the population census data of 1974 and 1988, population of Jesus de Otoro Municipality increased from 8,211 persons to 13,632 persons at an annual growth rate of 3.69%. This growth rate is close to that of the national average (3.63%) and higher than that of Intibuca Department average (2.99%). Population of Jusus de Otoro Municipality is estimated to be approximately 16,300 persons in 1993 assuming that the population grew at the rate of 3.6% per annum during 1988 and 1993.

About 31% of the total population are living in the municipal town and the remaining 69% are living in rural areas.

(2) Population in Jesus de Otoro Valley

Population of Jesus de Otoro Valley was 6,275 persons in 1988 including population in municipal town. Population of Jesus de Otoro Valley is estimated to be 7,500 persons in 1993 assuming that the population grew at the rate of 3.6% during 1988 and 1993.

3.3.3 Land Ownership and Landholding Size

(1) Land Ownership based on the Agricultural Census

The 1974 Agricultural Census office has classified land ownership in Honduras into private, national, rent, other forms and the mixture of these ownership. According to this census data, percentage of land ownership in Jesus de Otoro Municipality were 40.5 % for private, 23.7 % for national, 8.8% for rent, 16.2 % for private and national, 6.3 % for national and rent, etc. Land ownership in Jesus de Otoro Municipality was characterized by its

extremely higher percentage in the mixed form of ownership: "private and natinal", compared with the national average (refer to Table 3.3.3).

(2) Land Ownership at Reformed Sector

Land distribution to landless farmers and small landholders has benn carried out by INA based on the Land Reform Act. Farmer organizations such as farmer groups and associative enterprises have been organized as the land reform beneficiaries groups. Distributed land is divided into the land distributed to each member of the group and common land. At the common land, farming works and farm management are jointly carried out among the group members. Most of these land have been distributed with the provisional land usage right. INA is supporting these beneficiaries to obtain the land certificates instead of the provisional land usage right. There are 11 land reform beneficiaries groups in Jesus de Otoro Municipality with the total landholding of 912 ha or 1,303 manzanas (refer to Table 3.3.4).

(3) *Landholding Status in Jesus de Otoro Valley*

Landholders in Jesus de Otoro Valley can be classified into individual farmers and group farmers. Group farmers can further be subdivided into Farmer Groups (Grupos Campesinos) and Small Farm Groups (Comite Agricola). There are 8 farmer groups with the total landholding of about 720 ha, and 6 small farm groups with the total landholding of about 235 ha in the Valley. There is an autonomous village group called patronato in La Angostura which can be classified as individual farmers. In addition, RRNN has the land of about 54 ha. Landholding status in Jesus de Otoro Valley is summarized as follows.

	No. of Farms	Area (ha)
Individual Farmers	644	5,500
Farmer Groups	156	720
Small Farm Groups	98	235
RRNN	-	54
Total	898 *	6 509 **

Note: * Out of 965 farms, 7 % are considered to be the landless farms based on the 1988 Population Census.
** Area of municipal town is not included.

3.4 Present Agriculture in the Study Area

3.4.1 Present Land Use

(1) Land Use

Making an overview, approximately ninety per cent of the land in the valley is used for farmingland, grass land, orchard and forest land. In the farmingland, the staple crops such as rice, maize, beans, etc. are planted mainly and sugar cane, sorghum, millet, etc., supplementally. Vegetables are partly grown. Coffee and fruit such as orange, banana, pineapple, grape are also grown.

Grass land and the mixed land of grass and shrub or assorted trees that are found in wide area are utilized partially as pasture for large-sized live stocks.

(2) Vegetation

Vegetation in the Study Area was observed on the occasion of land use survey and sixty sorts of vegetation including wild plants and crops were identified. The result is shown in Table 1.3.2 in Annex B.

3.4.2 Farming Practice

The main crops in the Study Area are upland rice (irrigated and rain-fed), maize, field bean (*Phaseolus vulgaris*). These crops cover the majority of the planes in the Area. Banana, coffee and other orchard crops are cultivated only at the right bank of the Rio grande Otoro and the Rio Cumes, at fields observed to contain stones. Area cultivated with tomato are also gradually increasing; onions are also planted in some parts, while experimental cultivation of asparagus and grapes in ongoing. Meadows and grazing land cover a large part of the Study Area.

(1) Present Cropping Pattern

Present cropping pattern is shown in Fig. 3.4.1.

Upland rice cultivation is monoculture. Upland rice and maize cultivation start from the end of May, on set of the rainy season. Field bean is planted as intercrop in 25 - 30 % of the maize field. Field beans are planted in between rows of maize and planting starts when the culms of the crops are bent to dry the ears after reaching maturity. Semi-indeterminate (Catrachita) is twine themselves to the culms of these crops. Tomatoes and onions are transplanted from the nursery into the field after maize and/or field beans are harvested at the end of October when the rainy season ends.

(2) Present Farming Practice

Present farming practice in the Study Area based on the Farm Economy Survey and interviews with the farmers are explained hereafter (see ANNEX D, Tables 3.3.1 and 3.3.2).

Rice (irrigated and/or rain-fed upland rice), maize and field beans are planted by 67, 93 and 83 % of the farmers in the Study Area, respectively.

Ninety percent of the plowing and land preparation works are carried out by using hired tractors. Manual seeding is done by most farmers after furrowing by bullock, because only 35 seeders (pulled by bullock, plowed and seeded simultaneously) are available in the Study Area.

Rice: Seed is renewed frequently. Main seeding method is stripe seeding, while broadcast seeding is also adopted by some farmers. Fertilizer and herbicides are applied by all farmers, while insecticides and fungicides are only used by 81 % and 18 % of the farmers respectively. The amount of seed and fertilizer used is more then what is recommended.

Maize: Seed is renewed frequently. Seeding method is stripe seeding. Fertilizers, herbicides, insecticides and fungicides are used by 91 %, 56 %, 54 % and 1.2 % of the farmers respectively. The amount of seed and fertilizer used is more than what is recommended.

Field bean (Frijoles): Seed is renewed frequently, at every third cultivation. Seeding method is hill seeding. Fertilizers, herbicides, insecticides and fungicides are used by 83 %, 17 %, 29 % and 1.2 % of the farmer respectively. The amount of seed and fertilizer used is more than what is recommended.

Conclusively, it can be said that most farmers in the Study Area cultivate staple foods, i.e. maize and field beans, and use agricultural materials in their cultivation practices. But the amount of agricultural materials used for cash crop i.e. is much larger than those for staple foods. Although seeds are renewed frequently, the ones used are not of certified quality. These seeds usually come from good-yielding fields nearby.

3.4.3 Pests, Diseases, Weeds and their Control Measure

The main pest and disease which incur serious problems to the crops in the Study Area are shown below based on the information of the Extension Office, Ministry of Natural Resources, Jesús de Otoro. The countermeasures recommended by the Office are shown in Annex D, Chapter 3.

(1) Pests, Diseases and Weeds

1) Insects

Main insects in the Study Area are (1) army worms, cutworms which inhabit the soil and injure the stem, culm and roots, (2) green caterpillars which feed on leaves, (3) white flies and aphids which are vectors of viruses.

Attention should be paid to the fact that white fly (*Bemisia tabaci*) population is low in the rainy season and high in the dry season, especially in drought year.

Damages by Diamond-back moth (*Plutella xylostella*), insects said to have a tolerance to many insecticides and do serious damage to Cruciferae vegetables in the world, are not

observed in the Study Area may be due to the limited number of vegetables grown.

2) Disease

Rice blast (*Pyricularia oryzae*) is observed in some Cica-8 variety which is sensitive to it. But rice blast disease are expected to decrease gradually upon the implementation of the Extension Office's recommended cultivation of Cuyamel 38-20 and Guyamas 90, variety varieties to rice blast.

Sumt (*Entylama petuniae*, not identified in Japan), rust (*Uromyces phaseoli*), anthracnose (*Colletotrichum lindemuthianum*) and spot (*Phaeoisariopsis griseola*) are partly observed in field bean.

Tomatoes and vegetables are observed to be severely infected with viruses carried by vectors such as aphido (*Aphis sp.*) and white fly (*Bemisia tabaci*). When vegetables and fruit vegetables are cultivated, the prevention of white fly will be given importance in the Study Area.

3) Weeds

Gramineous and Cyperaceous weeds are common, while Solanaceous and Labiate weeds are only found in some parts.

4) Field mouse
Damages by field mice are not observed.

(2) Countermeasures (Agrochemicals)

Agrochemicals and fertilizers are available in six shops at Otoro City, two of which opened newly in May 1993. Big landowners, however, purchase at San Pedro Sula.

The agrochemicals and fertilizers sold at Otoro City are as shown below. Toxicity of agrochemicals are shown in Tables 3.4.1 and 3.4.2 in ANNEX D.

Kinds of Agrochemicals and Fertilizers sold at Otoro City

Agrochemicals and fertilizers	Number of Brands	Number of ingredients
Herbicides	15	7
Insecticides	24	17
Fungicides	11	7
Fertilizers	6	

All agrochemicals sold at Otoro city are registered under the Department of Plant Protection, Ministry of Natural Resources. But some of the following problems prevail:

Folidor, one of the insecticides recommended by The Extension Office at Otoro, is made up by methyl parathion. Compared with ethyl parathion, methyl parathion is acute oral and acute percutaneous toxicity with a median lethal dose (LD50), an amount considered to be small, however, when compared with other insecticides containing organic phosphorous. Counter (ISO: Terbufos) is also considered to be the same thing as Folidor.

The use of these agrochemicals should be prohibited, as is the case in Japan, and substituted with effective agrochemicals. Protectors should be worn when applying agrochemicals with high median lethal dose.

The application of Praquat, a herbicide, should be prohibited also like methyl parathion and terbufos. Although Paraquat's degree of toxicity is lower than methyl parathion and terbufos, the use of more than the lethal dose of the use of Paraquat can result in lesions and death a few days or several weeks later. The sales of Paraquat has been prohibited in Japan since 1987 due to the absence of effective medication to combat intoxication.

Depending on the amount and time of use, agrochemicals adversely affect fishes as well as they enter canals together with irrigation drainage. Endosulfan, the insecticide sold in Otoro, is particularly highly toxic to fishes hence requiring the people to refrain from washing implements in contact with chemicals in rivers.

Although the application of agrochemicals is necessary for pest and disease control in agriculture. These chemicals do not only adversely affect human health, but also kill the natural enemies of pests like birds and parasitic bees. The use of single agrochemicals, combined use of numerous insecticides, incorrect dilution of chemicals, the use of chemicals of varying degree of concentration kills natural enemies, creates pests and diseases with resistance to agrochemicals. Among the agrochemicals, Benomyl and Metalaxil are considered to easily create pest and disease with resistance.

For example, the use of Thionex (endosulfan) which is highly toxic to fishes , was permitted in orchards (coffee only) to counteract white fly which have developed resistance to other

chemicals.

Some agrochemicals even of similar ingredients are sold under different names. Also the degree of knowledge on agrochemical application vary by shop; even farmers are mostly ignorant of these practices and instead rely highly on brands and markers. The following precautions are considered necessary for the use of agrochemicals: (1) non-reliance on chemicals of a particular make-up, (2) the proper and timely application of agrochemicals, (3) the simultaneous application by farmers when pests or disease are forecast to break out. Therefore, it is necessary to be always in touch with the Extension Office and shops which sell agrochemicals.

Insecticides recommended in Japan to control white fly:

Buprofezin
Chinomethionate
Pyridaben

3.4.4 Agricultural Machinery

There are only very few agricultural machineries in the Study Area (see Annex D, Chapter 3.5). Only eight farmers own eleven tractors and contract to plow. Therefore seeding is not carried at a proper time due to shortage in tractors, even if two tractors belonging to the regional office of the MNR at La Esperanza come to help. Losses in paddy rice also occur during threshing due to a shortage in threshing machines, which leads to the beating of the grain with a wooden thresher-like tool. Because the number of threshing machines are not enough to work in the Study Area.

Capacity of agricultural machineries in the Study Area is as follows:

Capacity of Agricultural Machinery

Agricultural Machinery	Capacity
Tractor	4.0 ha/day
Threshing machine	4,500 kg/day
Drying machine	6,800 - 10,400 kg/day
Rice mill	3,600 kg/day

Besides tractors, draft animals (usually a pair of oxen) are used for plowing and furrowing. The working capacity of the ox is:

Working Capacity of Draft Animals

Work	Capacity (ha/day)	Note
Plowing	0.35	Crosswise
Furrowing	0.35	Rice
	0.70	Maize
	0.70	Field bean, one head of bullock

3.4.5 Crop Yield and Production

The Study Area covers about 8,140 ha of the farm land in the Otoro Valley, which is located below 700 m above sea level. Cultivation area, average yield and production are estimated for staple crops such as rice, maize, field beans and tomatoes. Tomatoes are the newly introduced crop in the Study Area. Cultivated area, average yield and production are as follows:

Yield, Area Cultivated and Production of Major Food Crops

Crops	Yield t/ha	Cultivated Area ha	Production ton
Rice			
Rain-fed	3.00	158	479
Irrigated (a)	3.50	1,287	4,505
Irrigated (b)	4.00	573	2,293
Maize			
Rain-fed	1.40	599	827
Irrigated (a)	2.20	274	603
Irrigated (b)	2.50	49	122
Field bean			
Rain-fed	0.70	335	248
Irrigated (a)	0.90	153	135
Irrigated (b)	1.00	10	10
Tomato			
Irrigated (a)	8.70	12	100

a: Present b: Plan

Rice (unhulled) Yield by Sampling Harves (400 sq m)

Variety	Yield (t/ha) Wet Paddy	Dried Paddy	Moisture Content (%)
Guyamas 90	7.7	7.0	25.7
Cuyamel 38-20	8.6	7.3	28.2

These rice varieties are high yielding varieties bred by Centro

Internacional de Agricultura Tropical (CIAT) in Colombia and planted widely in the Study Area. Irrigation and manuring practices in the field are extremely well compared with other fields in the Study Area. It seems that the yield obtained by this survey covers nearly the maximum yield in the Study Area.

3.4.6 Post Harvest, Storage and Agricultural Products Processing

(1) Post Harvest and Storage

1) Rice

Rice cutting is carried out manually. After collecting the rice cut, threshing is done by a threshing machine powered by a tractor engine or by beating panicles against the board. Rice after threshing are bagged, transported to the house and dried for a few days. It is then sold to the rice mill at Otoro City by most farmers or to the rice mill at San Pedro Sula by big landowners. Rice for family consumption is stored in bags within the house.

2) Maize

When maize is to be harvested, the culm just below the ear is bent and dried in the field. After bending the culm, maize is kept in the field, until the field beans are harvested, as a means of support for field beans. Ears are removed from the culm, bagged and transported to the house. Maize in the bag after the removal of the husk is threshed by club, seed is dried for a few days and stored in the metallic container. Or maize is stored without removing the husk from the ears and threshed by hand every day.

3) Field bean

Field beans are dried and threshed on a cloth or vinyl cloth in the field, transported to the house and dried for a few days before it is stored in the metallic container.

Loss in quality and quantity of crops harvested arise from incomplete and ineffective threshing and drying techniques and mechanization. These ineffective results in the occurrence of broken rice, usually 25 per cent of the yield and at times 100 %. Therefore, it is necessary to improve and extend these cultivation and processing techniques to reduce loss.

Sixty per cent of the households use a metallic container with a capacity of 150-200 lbs for storage and Phostoxin (Aluminum phosphate) is used to protect the seeds and grains in the container from pests. Phostoxin produces phosphine gas which is as toxic as hydrocyanic acid gas, and because it dose not emit an irritating smell, care should be taken to avoid intoxication as leakage may occur undetected.

(2) Storage Facilities

There are four storage facilities in the Study Area and they are used to store the newly harvested rise and maize grains for a short time until their time of sale. Maize and field beans for self-consumption are stored personally.

(3) Agricultural products processing

A agricultural products processing industries in the Study Area in Otoro City, where, five rice mills and eight flour mills, the latter grinding maize grain for tortilla are established. Farmers who live away from Otoro City use manually operated mills.

There is a slaughterhouse in the Study Area slaughtering one cattle on Thursdays and Saturdays and three on sundays. Meats are sold at the market in Otoro City.

3.4.7 Crop Profitability

Crop profitability has been examined for rice, maize, field beans and tomato. (See details in Annex D, Table 3.8.1).

Crop Profitability

Unit: Lps/ha

Crops	Cost				Income	Profit	Profit ratio
	Labor	Machinery	Material	Total			
Rice	918 (33)	516 (19)	1,348 (48)	2,783 (100)	4,000	1,217	1.44
Maize	402 (25)	473 (30)	716 (45)	1,591 (100)	1,802	211	1.13
Field bean	102 (56)	43 (6)	268 (38)	712 (100)	814	102	1.14
Tomato	1,994 (54)	473 (13)	1,253 (33)	3,721 (100)	5,232	1,511	1.40

Figures in parentheses are ratio of each cost to total expenditure

Rice and tomatoes showed greater profits than the others. Although field beans are not so profitable, the farmers cannot dispense with it since it is, like maize, a staple food. Less inputs are used for field bean cultivation and hired labor is seldom used to reduce the production cost.

3.4.8 Animal Husbandry

Grasslands and pastures cover about 50 percent of the Study Area and animal husbandry is the main agricultural activity in the Study Area. There are 95 stock farms in the Study Area with about 6,000 stocks. The cattle bred in the Study Area are Brahmans (about 75 %), Brahmans crossbred with Criollos (about 25 %) and very few Criollos. Several Holsteins, milking cows, are also bred in the Study Area. The number of calves born annually represent 10 % of the cattle population. Aside from the stockbreeder of Otoro City, cattle os also purchased by farmers from mountain areas.