Composition of Cattle in the Study Area

Items	Cow			Bull				
Age	0-2	2-3	Adult	0-1	1-2	2-3	Adult	Ox
Number of heads	647	1,493	2,008	584	288	311	83	227
Ratio (%)	11.5	26.5	35.6	10.4	5.1	5.5	1.5	4.0

Source: Departamento Ganaderia, Regional # 9, La Esperanza)

Cattle in the Study Area usually graze on pastures and after the crop harvesting, on fields consuming crop residue. The grazing area is mainly covered with Jaragua (*Hyparrhenia rufa*), and grass considered not good for cattle grazing. Therefor, with the guidance by the Agricultural Extension office in Otoro, species like Kudzu (*Pueraria phaseoloides*) and Otoreño I (*Andropogon gayanus*) introduced from CIAT, Colombia were recently cultivated. The pastures are cultivated normally without fertilization and is only partly irrigated in the dry season. To compensate for feed shortage in the dry season, some cattle are transferred to the mountains with comparatively large rainfall.

It is estimated that there are approximately 2,000 draft animals (oxen) other than those in stock farms, judging from the number of wagons registered in Otoro municipal office. Livestock population other than cattle in the Study Area, is made up of 1,000 - 2,000 donkeys for transportation, 3,000 - 6,000 chicken and 200 - 1,000 pigs.

The depletion of crop residues reserves and withering of grass in the dry season results in feed shortage and remarkable weight loss among 70 percent of the cattle population. Death ratio, which is zero in the rainy season, rises up to 3 percent in the dry season.

3.5 Agro-economy

3.5.1 Marketing of Farm Products

(1) Rice

Although rice is classified as one of basic grains in Honduras, rice can be classified as one of the most important commercial crops in Jesus de Otoro. However, marketing channels of rice are complicated and the definite marketing channel for rice has not been established yet. There are five rice mills in Jesus de Otoro town, of which four mills are operated by grain intermediaries and the remaining is operated by EACTSO. Rice is presently marketed through several channels such as: (a) producers to intermediaries; (b) farmer groups to EACTSO; and (c) producers to rice mills in Siguatepeque, Comayagua, San Pedro Sula and Tegucigalpa. Data on the volume of rice marketed through each channel are not available.

Assuming per capita consumption of rice of 20 kg, annual consumption of rice in Jesus de Otoro is estimated at 326 mt of milled rice or 540 mt of unhulled rice. Therefore, approximately

6% of rice produced in the municipality are consumed locally and the remaining are marketed through the channels as mentioned above.

(2) Maize and Frijoles

Based on the results of the Farm Economy Survey, small scale farmers consume the majority of their product (maize) at home. In the case of medium and large scale farmers, however, 50 to 80% of their maize are marketed. Regardless of farm size, about 50% of frijoles are marketed. It is estimated that maize and frijoles are marketed through intermediaries to Siguatepeque, Comayagua and Tegucigalpa.

(3) Tomato

Although definite data on tomato production are not available, it is estimated that about 100 mt of tomatoes have been produced in Jesus de Otoro municipality based on the seeds volume sold in the municipality. Some of these tomatoes are marketed to municipal town and Siguatepeque as fresh tomatoes and some are sold to tomato factories in Comayagua.

Tomato production in Honduras increased at the annual rate of 9% during 1987 and 1991. Majority (90%) of tomatoes have been produced in Comayagua valley. About 90% of tomatoes produced in Comayagua valley have been processed in tomato factories in Comayagua, which have been sold to domestic and foreign markets including Guatemala and El Salvadore. It is estimated by tomato producer (Cressida) and tomato processors (ALVASA and Mejores Alimentos) in Comayagua that tomato demand will increase by 10% annually from now onwards including domestic and foreign markets.

A tomato producer in Comayagua is not only buying farm land for cultivation of tomatoes, but also planning to make annual contract with farmers in Jesus de Otoro valley for tomato production in order to cope with the growing demand of tomatoes in the future. Therefore, there is great possibility that tomato cultivation under an annual contract with the tomato producer in Comayagua will extensively increased in Jesus de Otoro valley after establishment of the improved iriigation system.

(4) Other Vegetables

Although some other vegetable such as onion, turnip and cabbage are produced in Jesus de Otoro Municipality, production of these vegetables is not sufficient to meet the demand in the municipality. Vegetables such as onion, cabbage, carrot, garlic, and cucumber produced in neighboring cities (La Esperanza and Siguatepeque) are sold in the public market in the municipal town.

(5) Livestock Products

More than 90% of farmers in Jesus de Otoro are engaged in livestock farming. In addition to the breeding of cattle which

is the major livestock farming in Honduras, swine raising and poultry farming are also conducted. Main livestock products are beef, pork, chicken, milk, eggs, cheese, etc. Small and medium scale farmers usually consume beef and milk at their home and sell chicken and eggs. In the case of large scale farmers, chicken and eggs are consumed domestically and cattle, milk and cheese are sold in the municipality and other cities. Most of live cattle are sold through intermediaries to San pedro Sula and Tegucigalpa.

(6) Public Market

There is only one public market in Jesus de Otoro Municipality, located at the central area of the municipal town. The market has twelve stalls which are rented to vendors at twelve Lempiras. Slaughter of cattle is usually carried out every Saturday and Sunday to sell beef in the public market.

3.5.2 Prices of Farm Products

Farm gate prices of major farm products have been estimated on the basis of the market prices as of July 1993, taking into consideration transport cost between the farm and market. Prices of fresh and processing tomatoes are considerably different and it is estimated that approximately 85 to 87 % of the total tomatoes produced in Honduras are processed in tomato factories. Farm gate prices of major farm products are presented below.

Farm Products	Farm Gate Price (Lps/kg)
Unhulled rice	1.03
Maize	0.88
Frijoles	1.30
Tomato (processing)	0.80
Tomato (fresh)	1.20
Cucumber	1.00
Beef	11.00

3.5.3 Farm Economy

Farm income analysis has been made for the representative farms in the Study Area depending on their farm size. Based on the results of the Farm Economy Survey conducted during the first phase of the Study, farms in the Study Area have been categorized into three: i.e. small scale farmers with landholding of less than 5 ha, medium scale farmers with landholding of 5 to 50 ha, and large scale farmers with landholding of more than 50 ha.

Small scale farmers have approximately 2.5 ha of land on the average. Production of basic grains is their major farming activities and livestock farming accounts for about 30% of the total farm income. Gross farm income including livestock and off-farm income amounts to 7,267 Lempiras. However, net farm income after deducting household expenditures amounts only to 1,730 Lempiras.

Medium scale farmers have approximately 10 ha of land on the average. Production of basic grains is their major farming activities and livestock farming accounts for about 30% of the total farm income. Gross farm income including livestock and off-farm income amounts to 21,302 Lempiras. Net farm income after deducting household expenditures amounts to 8,840 Lempiras.

Large scale farmers have approximately 200 ha of land on the average. Production of basic grains and livestock farming are their major farming activities. Livestock farming accounts for about 28% of the total farm income. Gross farm income including livestock and off-farm income amounts to 273,135 Lempiras. Net farm income after deducting household expenditures amounts to 170,966 Lempiras.

Farm Household Income Analysis 1/

Income 2/	Small Scale Farmers (2.5 ha) 3/	Medium Scale Farmers (10 ha) 3/	Large Scale Farmers (200 ha) 3/
Crop Income	5,111	14,177	208,425
Livestock Income	1.189	4,488	49,310
Farm Income	6,300	18,665	257,735
Off-farm income	967	2,637	15,400
Gross household income	7,267	21,302	273,135
Household expenditures	5,537	12,462	102,169
Net income	1,730	8,840	170,966

Note:
1/ See details in Tables 4.6.2, 4.6.3 and 4.6.4, ANNEX E.
2/ Unit in Lempiras
3/ Classification of farms is based on the farm landholding size.

3.6 Agricultural Supporting System

3.6.1 Research and Extension

The Research and Agricultural Extension Agencies supporting agricultural activities in the Study Area are:

(1) Agricultural Extension Office in Jesus de Otoro

The Office consists of four sections, i.e. 1) Animal husbandry, 2) Improvement of farmers' living conditions and organization of farmers, 3) Agricultural extension, 4) Agricultural research.

Agency employs' 16 workers with the following educational history: six workers with 16 years of education, four workers with 12 years of education, six workers under six years of education. As most of the workers are under a one-year contract with Ministry of Natural Resources, they are usually restless and insecure, moving one place of work to another, therefor, making the continuous offering of extension services to farmers difficult. Only one worker out of all the workers employed in the first study phase is employed in the second study phase.

(2) Technical Cooperation by the Government of Spain (Institute de Cooperation Iberoamericana)

Technical cooperation on agriculture by the Government of Spain is carried out with the Instituto Nacional Agrario (INA), and the Ministry of Natural Resources (RRNN) as counterparts. Their activities in the Study Area cover education, agricultural extension activities and improvement of farmers' living condition and are divided among counterparts. The office consist of one team leader dispatched from the Government of Spain and 17 Honduran workers. Among the 17 workers, six were dispatched from INA and one worker was despatched from RRNN.

(3) Fundación Hondureña de Investigación Agricola (FHIA)

FHIA is a private foundation organized in 1984 by the assistance of the Government of Honduras and the United States Agency for International Development (USAID). Its headquarters in Lima, Cortez and its two Agricultural Experimental Stations are in La Esperansa and Comayagua. FHIA provides specialized services to the agricultural sector on a partial cost basis, and these services include soil survey, selection of crops (including crops for export) based on the soil and climate, formation of plan on irrigation and drainage plan, chemical, soil, foliar tissue analysis and pesticide residue assessment, diagnosis of pests and diseases, guidance concerning countermeasures against pests and diseases. The experimental cultivation of asparagus commenced in November 1992 with help of the Government of Spain.

(4) Pan American Agricultural School (Escuela Agricola Panamericana, EAP)

EAP was established in 1941 as a private, agricultural school in El Samorano, Francisco Morazon. Many of the students come from

Honduras and South and Central America and they are trained to be leaders directly involved in agricultural production through crop selection and livestock breeding. EAP has carried out the integrated Pest Prevention Program primarily in Comayagua, where white flies are plentiful, dominant pest and other area.

(5) Agricultural Development Training Center (Centro de Entrenamiento de Desarrollo Agricola, CEDA)

CEDA in Comayagua, Comayagua, was established by the cooperation of the Japanese Government (cooperation was terminated in December 1992). The center conducts training programs mainly for farmers and experts in the field, and the number of attendant in the course held in the Study Area was 9 by the end of December 1992.

We can conclude from the above that the Agricultural Extension Staff are indeed actively pursuing their duties. However, shortage in staff and vehicles impede the continuance of detailed guidance in the Entire Study Area. But if the cooperation of FHIA, EAP and CEDA will be acquired, countermeasures for agricultural problems can be easily and smoothly realized.

3.6.2 Agricultural Credit

Agricultural Development Bank (BANADESA) is an autonomous government institution providing agricultural credit for the farmers in Honduras. BANADESA has 35 branch offices all over the country, including La Esperanza office in Intibuca Department. La Esperanza branch office opened a local office in Jesus de Otoro in 1991. Agricultural credit services of BANADESA has been provided to farmers in Jesus de Otoro Municipality through Jesus de Otoro office and La Esperanza office for production of crops. Loan beneficiaries include private farmers, asociativa enterprises, and farmer groups. Loan interest rates depend on the source of the fund, loan period, and products. Current interest rates (as of 1992) are 14% for basic grains production, 17% for livestock farming, 22 to 24% for commercial and industrial activities. In 1991, BANADESA provided 341 loans amounting 495,040 Lempiras in Jesus de Otoro, of which the majority (83%) were directed for rice production.

In January 1993, Banco de Occidente S.A., a private bank, opened a branch office in Jesus de Otoro to provide loans for coffee production, basic grains production and livestock farming. This bank has provided 3 million Lempiras during January and August 1993, of which about 50% has been directed for basic grains production.

3.6.3 Farmer Organizations

As mentioned earlier (3.3.3), there are 11 land reform farmer organizations in Jesus de Otoro Municipality. These organizations consist of Farmer Groups (level-1), Associative Enterprises for agricultural production (level-2), and Associative Enterprises for agricultural processing and marketing (level-3). Out of these

farmer organizations, six groups (Guayaman, Tatumbla, Juan Benito Montoya, Ismael Cruz, Agricola and Crucita Oriente) were transformed from level-1 groups to level-2 enterprises under technical support from the National Agrarian Institute (INA) and MNR. These groups formed a level-3 Associative Enterprise called EACTSO in 1991. Main objectives of this associative enterprise are: (a) provision of credit for basic grains production; (b) provision of agricultural production inputs; (c) rent of agricultural machinery; and (d) purchase of unhulled rice, processing and sale of milled rice.This enterprise has the rice milling facility in municipal town and selling milled rice to neighboring cities without channeling any intermediaries.

In addition to the assistance for the landless farmers, Honduran government has also been providing technical and financial assistance for small land holders with less than 5 ha. These small land holders formed small farms groups (comite agricola) to obtain technical and financial assistance from MNR, INA and BANADESA. There are 18 small farms groups in Jesus de Otoro Municipality, of which six groups (Santo Domingo, Maye Independiente, San marcos, El Esfuerza, Santa Cruz and Lealtad) are located in Jesus de Otoro Valley.

In addition to the above, there are some rural organizations such as patronato which is an autonomous village group (e.g. distribution of irrigation and drinking water is arranged by executive members of patronato in La Angostura village), women club whose members are wives of farmers, coffee producers cooperative (Cooperativa Agropecuario Otorena Ltd), livestock producers association (Asociacion Ganaderia de Otoro), etc.

3.7 Irrigation and Drainage

3.7.1 Existing Irrigation Systems

At present there are many irrigation systems which take the water from the several tributaries of the Grande de Otoro River which runs along the center of the valley. These systems have been developed since 1954. The first system consisted of an intake facility constructed upstream of the Santa Cruz Stream and the conduction channel up to the reservoir located to the east of Jusus de Otoro municipality. Later on, the associated and non-associated farmers constructed the intake facilities in the Yucanguare River, and from then on the development of the irrigation systems have been accelerated in the several tributaries and streams of the valley. At present the irrigated area totals approximately 3,000 ha as presented below.

Existing Irrigation Areas in the Otoro Valley

Water Sources	Irrigation Area (ha.)
Yucanguare River Basin	527.7
Naranjo River Basin	556.5
Mixcure River	581.4
Santa Cruz Stream Basin	377.9
Cumes River Basin	425.9
Aro River Basin	36.1
Others	463.5
Total	2,969.0

All the existing systems consist of the installation of irrigation facilities at each farm constructed by the associated or non-associated farmers, without any organized coordination among the irrigation systems. Likewise, all the systems are small.

The intakes are constructed mainly with the available stones in the river (some are constructed using concrete with a few exceptions). Such facilities are easily flowed down by the strong streams of water during the rainy season, and must be reconstructed at the end of the season.

The water taken from the rivers is conducted through the canals laid out in parallel with the river's borders, reaching the flat farm lands. Where enough space is available, the canals are constructed with the same river stones, while in the sites with little space or accentuated relief, canals with concrete lining or pipelines are constructed to convey water to farm lands.

The main canals which cross the farm are earth canals and run perpendicularly to the contour lines. Its gradient is very steep and has no drop structures. There exist some secondary canals which serve to conduct the irrigation water from one parcel to another.

At present the existing irrigation area within the Study Area, totals approximately 3,000 ha. However, this figure corresponds only to the irrigable area in the rainy season. In the dry season, it reduces to 500 ha.

3.7.2 Operation and Maintenance of the Irrigation Systems

The operation and maintenance of the main irrigation facilities have been conducted under the responsibility of Directorate General of Water Resources (DGRH) of the Natural Resources Ministry (RRNN). The participation of the users was limited to the maintenance of the secondary canals, consisted of cleaning of sedimented soils and elimination of weeds. However, the awareness of the users about the importance of the good maintenance and operation has been scarce. Therefore, these works have not been performed properly.

In such a situation, the Government of Honduras introduced, under

the agriculture modernization policy, the privatization of irrigation districts and decided to hand over facilities and irrigation systems to the users transferring the responsibility of its operation and maintenance to them, except the large structures such as dams. At present organization process of water users has been promoted for such purpose. According with this arrangement, the Government will construct the necessary facilities for the operation and maintenance, such as administration offices, warehouses, etc. and also will repair the existing facilities, in order to later on hand over the facilities to the users organizations. In the following phase the Government will suspend completely the support to the farmer organizations, in order they take in charge of the operation and maintenance of the facilities.

Within this framework, a warter users organization will be formed at each irrigation district. These organizations will take the responsibility of operation and maintenance of all related facilities including the intake facility, and its costs will be covered entirely with the water charges paid by the water users.

According to the collected information, traditionally the operation and maintenance of the irrigation facilities in Jesus de Otoro have been made under the assistance of the Otoro Agriculture Branch Office which belongs to the Agriculture Department of South West Regional Office of the Ministry of Natural Resources (MNR) in La Esperanza. However, there is no officer from DGRH in this office, and its function is limited to offer agricultural supporting services such as extension, social promotion and research activities.

In the situation as mentioned above, the operation and maintenance of the facilities have practically been under the responsibility of the respective users and at present there is no organization of control which integrate all the facilities. Each irrigation system is of small dimension, so maintenance works are made annually by the proper initiative of the user's groups.

Due to the existence of a large number of irrigation systems along the rivers, there have been frequent conflicts among the users in relation to the rights of water use, especially in the dry season. This situation was seriously aggravated when the region was affected by the prolonged drought of 1991. As a countermeasure, a water control committee was organized, integrated by the representatives of the Natural Resources Ministry, Jesus de Otoro municipality, and the users, with the purpose to elaborate the regulations on the water use which solve the conflicts. This committee was organized temporarily, and it is presently inactive (since 1992).

3.7.3 Drainage

As has been previously mentioned, the Study Area is located in the Otoro valley at an elevation of 600 m.a.s.l. The Grande de Otoro River flows through the valley which is surrounded by the mountains of 1,000 to 2,000 meters of elevation. Many tributary rivers and streams flow into the Grande de Otoro River, and in

both sides of these rivers and streams, the farm lands extend. The longitudinal gradient of the tributaries is more than 1/100 against the Grande de Otoro, forming in this way the relatively deep valleys. Transversely, the land along these rivers and streams gradually rise.

The main drainage channel of the Study Area would be the Grande de Otoro River, while its tributaries also would play an important role in evacuating the water. Up to now there have been no record of flood damage along the Grande de Otoro River, except such damage in arable land formed within the river channel because their bed is located at an elevation remarkably lower than their sides. Neither the basins of the streams and brooks have been flooded up to now, because the flood produced by the accentuated reliefs form rapid streams, flowing through the river bed located at a lower elevation.

The drainage water from furrow irrigation area is evacuated towards the nearest natural water course. The artificial drainage channels are few and in most cases the water accumulated in natural way in the lowest part of the crop lands is evacuated to the river by effect of the gravity. Therefore, often puddles and small marshes are formed at the end of cultivated lands. It is necessary to take concrete measures; for example, the construction of field drainage channels.

3.8 Rural Infrastructure

3.8.1 Roads and Bridges

The main road network existing in the Jesus de Otoro Valley is composed of an asphalt paved road (7.2 m in width) of 70 km connecting La Esperanza with Siguatepeque and 4 gravel roads of 89km in total connecting Masaguara with San Isidro and villages in the Valley.

The total length of the rural roads connecting villages with the main road network is about 62 km with 3-6 m in width. Their traffic is difficult in some parts during the dry season and impassable during the rainy season because of lack of adequate pavement, structures for drainage such as ditches and culverts, and bridges crossing rivers and streams (Fig 3.8.1).

The construction of these roads is under the responsibility of the General Directorate of Roads and their maintenance is under the General Directorate of Conservation of Roads and Airports both under the Ministry of Communication, Public Works and Transportation (SECOPT).

The roads under the responsibility of the SECOPT are as follows:

Project	No. of Road	Length(km)	Content	Situation
Siguatepeque -La Esperanza	22-20,22-30	70	Pavement	Under Const.
Jesus de Otoro -San Antonio de Masaguara	654	13	O/M	Plan (93-96)
Jesus de Otoro -Quiraguira	664	13.5	O/M	Plan (93-96)
Santo Domingo -San Isidro	660	14	O/M	Plan (93-96)
Jesus de Otoro -El Palmar		3	Const.	Decided
San Marcos -El Porvenir -Las Cricitas	670	10	Rehab.	Under Const.
Crucitas -San Rafael	670	2.2	Rehab.	Under Const.
Los Alpes -La Enea -San Rafael	670	8.2	Rehab.	Under Const.
J, de Otoro -Santa Fe Arriba		4	Const.	Under Const.
Las Cricitas -El Ingerto		5	Rehab.	Under Const.
Maye -El Aguacate		5.7	Const.	Under Const.
Carretera22-30 -San Francisco		3	Const. Rehab.	Under Const.
Carretera22-30 -Santo Domingo	660	4.7	Const.	Under Const.
Jesus de Otoro -San Antonio -Union Praga		5	Const. Rehab.	Under Const.
Santo Domingo -Guayaman		3.8	Rehab.	Under Const.

Note: Const.= Construction, Rehab.= Rehabilitation

3.8.2 Electrification and Water Supply

(1) Electrification

Jesus de Otoro Valley is interconnected to the national electric system generated by El Cajon Hydroelectric Central, through a transmission line of 34.5kv (triphase) which connect with the city of Siguatepeque. This service is administrated by National Company of Electric Energy (ENEE, Empresa Nacional de Energia Electrica), which supply energy to 492 subscribers for the Jesus de Otoro City and 28 subscribers for the Masaguara City in 1991.

The transmission line of 34.5kv allows the electrification of the whole study area, but the rest of villages in Jesus de Otoro Valley lack of electric supply because the installation cost of the secondary and domestic distribution system is requested and financed by the beneficiaries.

(2) Water Supply

All of the water supply systems existing in the study area are composed of the sources of water of rivers, streams and springs and gravity distribution systems.
In 1993, the construction of gravity water supply systems was commenced in 5 city and villages, Jesus de Otoro City and villages of San Marcos, Las Tranquitas, La Coyotera and Hacienda El Porvenir. After completion of them, the existing water supply systems will cover whole 20 villages with 1,337 households and 11,785 persons. The number of villages without water supply systems will be only 3 villages with 9 households and 54 persons. Otherwise, a groundwater development project has been studied for the water supply in 5 villages of Comontan, San Miguel, Santo Domingo, Llano de Maye and La Angostura. It will contribute to improvement of quality of supplying water.

3.8.3 Transportation and Communications

(1) Transportation

The regular service of passengers transportation in Jesus de Otoro Valley is provided by private bus companies which connect Jesus de Otoro City with the cities of Tegucigalpa, San Pedro Sula, Siguatepeque, La Esperanza and Masaguara through the asphalt paved road and Route No.654.

Other transportation is to move on foot or to pickup vehicles that eventually circulate through the zone.

With respect to motor vehicle freight transportation, it is also limited to the area of influence of these roads and it is generally moved by medium capacity vehicles (3 to 10 tons). On the rest of the roads, the freight transportation means most commonly used consist of oxen-haulted carts or beast of burden where only footpaths exist.

(2) Communications

The existing communication system at the Jesus de Otoro Valley is composed of the telephone, telegraph and the mail services. The telephone system is composed of a public telephone line which allows communication to any part of the country and a telephone network for internal use within the Valley which communicates Jesus de Otoro City with Masaguara, San Isidro, San Jeronimo and San Rafael.

The telegraphic network only allows communication with Masaguara and La Esperanza.

A mail office is in the Jesus de Otoro City, and its distribution is only made within Jesus de Otoro City.

3.8.4 Health, Sanitation and Education

(1) Health

Within the Study Area there are a Health Center with a Physician and an Odontologist (CESAMO) at the Jesus de Otoro City and two Rural Health Center (CESAR) at the villages of San Rafael and San Jeronimo under the care of an Auxiliary Nurse.
Medical attention in the study area is provided by the Jesus de Otoro's CESAMO, which had an average of 685 consultations per month in 1991.

According to medical attention statistics, malaria ranks first as the severe disease with higher incidence in the study area, followed by gastrointestinal and diarrheic infections and malnutrition cases among the infantile population.
Since October, 1992, this CESAMO does not provide professional medical attention because being its staff under the Social Service Program, they have not been replaced by the Secretariat of Public Health once they concluded their professional practice. Emergencies and professional medical attention cases are transferred to the Area No. 2 Hospital, located at the city of La Esperanza (40km).

(2) Sanitation

According to the 1988 Census, of the 878 total houses that the Jesus de Otoro City had, only 3 streets were connected to the sewerage system (80 houses) and 300 had latrines.
Presently, houses in the rural areas have latrines and this is so because private organizations which are financing the construction of new water supply systems demand that the beneficiaries construct their own latrines and also that they comply with environmental sanitation regulations.

(3) Education

Jesus de Otoro Municipality had within its sphere 37 elementary schools, with a total of 3,238 registered pupils and 85 teachers in 1992. Thirteen schools out of these schools are within the Project area. They are of influence of 2 to 3 km, which allows to cover the education necessities of the area under study; however, in rural areas each teacher has an average of 51 pupils, which is a high number if it is considered that teachers are in charge of teaching several grades simultaneously.
Besides, Jesus de Otoro City has a Secondary Education school, which covers the three-year Common Cycle Program with 349 students and 17 teachers.

Table 3.2.1
(1/2) PRINCIPAL CHARACTERISTICS OF SOILS OF THE JESUSU DE OTORO VALLEY

NOMBRE DE LA UNIDAD DE MAPEO (SIMBOLO)	POSICION FISIOGRAFICA Y RELIEVE	PROFUNDIDAD EFECTIVA (Cms)	SUELO SUPERFICIAL (0-30 cm)			SUELO SUB-SUPERFICIAL (>30cm)			DRENAJE NATURAL	ORIGEN	LIMITANTES
			COLOR	TEXTURA	CONSISTENCIA	COLOR	TEXTURA	CONSISTENCIA			
MAYE (NAY)	Pie de monte y terrazas altas/Plano inclinado	0 - 50 50 - 80	Café Oscuro	F/FA	Friable,de lig Adh.a adherente y lig plastica a plastica	Café grisaceo muy oscuro	A	Adherente a muy adherente plastico	Imperfecto	Coluvio Aluvial	Pedregosidad superficial y afloramientos rocosos abundantes
COMONTAN (COM)	Lomerio/ Ondulado	40 - 75	Café Oscuro	Fa/FAa/A	Friable,lig Adherente a adh y lig plastica a plastica	Café oscuro	A	Adherente y plastica	Imperfecto	In Situ	Pedregosidad superficial y afloramientos rocosos abundantes
SAN MIGUEL (SMi)	Terrazas altas y Pie de monte/ Plano inclinado	50 - 100	Café oscuro a Café grisáceo Muy oscuro	F/Fa/FA/A	Friable, No Adherente a adh y lig plastica a plastica	Café grisaceo muy oscuro a café oscuro y negro	A/Aa/FAa	Friable a firme, adherente y plastica	Imperfecto a Pobre	Aluvial Antiguo	Existe areas con pedregosidad superficial abundante
EL PARAISO-GUAYABA (PA-GU)	Pie de monte/Lig inclinado	70 - 100	Negro	F/FAL	Friable/lig adh a adherente Y lig plastica	Café grisaceo muy oscuro a café oscuro	A/FA	Friable/lig adh. a adherente y lig. plastica a plastica	Moderado a imperfecto	Aluvial Antiguo	
SAN FRANCISCO SANTO DOMINGO (SF-SD)	Pie de monte/ inclinado	25	Café oscuro a café Amarillento Oscuro	F/F Aa	Friable/lig Adherente, lig Plastica				Moderado a Bueno	In Situ	Piedra y roca en el Perfil: pedregosidad superficial y afloramientos rocosos abundantes
LAS LOMITAS (LOM)	Terrazas altas/Lig ondulado a Ondulado	50 - 70	Café Oscuro	F/Fa/A	Friable/lig adh a adh lig plasta plastica	Gris muy oscuro	A	Firme/adh y plastica	Moderado a Imperfecto	In Situ	Algunas areas muestran pedregosidad superficial abundante
SAN LORENZO-LA PRADERA(SL-PRA)	Terrazas altas/ Lig inclinado a Lig ondulado	60 - 80	Café oscuro Café amarillento Oscuro	F/Fa/FA	Friable a firme/No adh a adh y no plasta plastica	Café grisaceo muy oscuro, café oscuro rojo oscuro	A	Firme/Adherente y Plastica	Imperfecto	Aluvial Antiguo	Algunas areas son superficiales (35cm), otras tienen pedregosidad superficial y afloramientos rocosos
EL CIPRES-GUAYAMAN (ECL-GUA)	Terrazas altas/Casi plano a plano Lig inclinado e inclin	20 - 45	Café oscuro	F/Fa/FAa	Friable/no adh a lig adh y no plast a lig plastica	Café oscuro	FA/FAa gr	Friable/adherente y lig. plastica a plastica	Moderado a Imperfecto	In Situ	Pedregosidad superficial abundante, afloramientos rocosos abundantes. Grava en el perfil
AGUA BLANCA (AGUB)	Terrazas Altas Plano Inclinado	60 - 80	Café amarillento grisáceo o oscuro	FA-F	Friable lig, Adher lig, Plast	Café negro	A	Firme Adherente Plastica	Imperfecto	Coluvio/ In Situ	Piedras grandes, 5-10% del volumen del 2do horizonte

Table 3.2.1
(2/2) PRINCIPAL CHARACTERISTICS OF SOILS OF THE JESUSU DE OTORO VALLEY(CONTINUED)

NOMBRE DE LA UNIDAD DE MAPEO (SIMBOLO)	POSICION FISIOGRAFICA Y RELIEVE	PROFUNDIDAD EFECTIVA (Cms)	SUELO SUPERFICIAL (0-30 cm)			SUELO SUB-SUPERFICIAL (>30cm)			DRENAJE NATURAL	ORIGEN	LIMITANTES
			COLOR	TEXTURA	CONSISTENCIA	COLOR	TEXTURA	CONSISTENCIA			
OTORO (OTO)	Terrazas Altas Casi Plano	50	Café negro	F	Friable No Adherente No Plastico	Café negro	A	Firme Adherente Plastica	Imperfecto	Roca volcánica de terciario/ In Situ	40% de piedra grande en todo el perfil. Pedregosidad moderada en la superficie
ARROZALES (ARRO)	Terrazas Altas Casi Plano	80	Café negro	F-A	Friable No Adh. A Adh. No Plast. A Plas	Café negro	A	Friable Adherente Plastica	Imperfecto	Aluvial Antiguo	Pedregosidad Superficial Moderada
MORALES (MOR)	Terrazas Altas Legeramente Inclinado	50	Café negro	Fa	Friable No Adherente No Plastico	Café negro	A	Firme Adherente Plastica	Imperfecto	Roca volcánica	Pedregosidad Superficial abundante
EL PORVENIR (POR)	Pie de Monte Plano Inclinado	30 - 50	Café negro	F-Fa	Friable No Adher. No Plastica	Café negro	A	Firme Adherente Plastica	Imperfecto	Roca volcánica de Terciario/ In Situ	Pedregosidad Superficial Moderada. Afloramientos Rocosos Moderados
EL PITAL (PIT)	Terrazas altas/ Lig inclinado a Ondulado	80 - 90	Café amarillento grisáceo	aF-FA	Friable/ No Adh a lig Adh y no plasta a lig plasta	Café amarillento grisáceo	A	Firme Adherente y plastica	Moderado a Imperfecto	Aluvial Antiguo	
SUELOS DE VEGA (VE)	Terrazas bajas/ Casi plano a lig Inclinado y lig ond	100 - 200	Café oscuro Café amarillento Oscuro gris muy oscuro	Fa-aF FA-FAa	No adherente no Plastica/ Adherente y Plastica	Café grisaceo muy oscuro café, café oscuro	Fa FA/FAa	No adherente No plastica Adherente y plastica	Bien Drenado	Aluvial	

Table 3.2.2 LAND CLASSIFICATION BY USE CAPABILITY

UNIDAD DE MAPEO	CLASE DE CAPACIDAD	SUB-CLASE DE CAPACIDAD	UNIDAD DE CAPACIDAD	OBSERVACIONES
Maye(MAY)	III – IV	sd	III-Nsd	Textura fina, drenaje y piedras superficiales
		std	III-Nstd	Profundidad efectiva, texture, fina, piedra superficiales, drenaje y topográfia
Comontan(COM)	III – IV	sd	III-Nsd	Textura fina, drenaje, contenido de grava, rocas superficials, rocas en areas no cultivados e topografia
San Miguel(SMI)	III – IV	sd	III-Nsd	Textura fina y drenaje
	VII	sd	IIIsd	Textura fina y drenaje imperfecto
El Paraiso Guaysbal (PA-GU)	III – IV	sd	IIIs	Textura y drenaje
San Francisco Santo Domingo (SF-SD)	VII	s	IIIs	Rocas superficiales en exceso y rocas en areas no cultivadas
Las Lomitas(LOM)	III – VI	sd	III-Nsd	Textura fina, drenaje
		std	III-Nstd	Textura fina, drenaje y topografia
San Lorenzo-La Pradera (SL-PRA)	III – IV	sd	III-Nsd	Textura fina y drenaje
		std	III-Nstd	Textura fina, drenaje, piedras superficiales y topografia
El Ciprea Guayaman (EC-GUA)	IV	sd	Nsd	Presencia de grava en perfil, drenaje, piedras superficiales y topografia y Poca en predios no cultivados
Agua Blanca(AGUB)	III	sd-15	IIIsd-15	Profundidad, textura fina y drenaje
Otoro(OTO)	IV	sd-36	IVsd-36	Roca profundidad, textura fina y drenaje
Arrozales(ARRO)	III	sd-44	IIIsd-44	Textura fina, drenaje y pedregosidad superficial
Moraales(MOR)	IV	sd-44	IVsd-44	Profundidad, textura fina, drenaje y pedregosidad superficial
El Porvenir(POR)	IV	std-44	Nstd-44	Profundidad, textura fina, drenaje y pedregosidad superficial
El Pital(PIT)	III	std-6	IIIstd-6	Textura moderada pedregosidad superficial
Vega(VEG o V)	II	s	IIs	Textura moderada
		t	IIt	Relieva
		st	IIst	Textura y relieve

Table 3.3.1 POPULATION TREND IN JESUS DE OTORO (1974-1988)

Aldea	1974			1988			Annual Rate of Increase (%)
	Family	Persons	Family Size	Family	Persons	Family Size	
Jesus de Otoro	923	4,324	4.68	1,502	7,028	4.68	3.53
a. Cabecera Municipal	663	2976	4.49	878	4174	4.75	2.44
b. Aldeas/Caseiros	260	1348	5.18	624	2854	4.57	5.50
Coclan	158	787	4.98	266	1,207	4.54	3.10
El Junquillo	78	419	5.37	131	674	5.15	3.45
San Antonio	56	294	5.25	154	735	4.77	6.76
San Jeronimo	140	738	5.27	267	1,200	4.49	3.53
San Rafael	302	1,649	5.46	512	2,788	5.45	3.82
Sub-total (2 - 6):	734	3,887	5.30	1,330	6604	4.97	3.86
Total:	1,657	8,211	4.96	2,832	13,632	4.81	3.69

Source: Censo Nacional de Poblacion y Vivienda 1974 y 1988

Table 3.3.2 POPULATION IN OTORO VALLEY (1988)

Aldea/ Caserio	1988		Family Size
	Family	Persons	
1 Cabecera Municipal	878	4,174	4.75
2 Chacaterique	3	10	3.33
3 Las Canoas	6	43	7.17
4 Hacienda La Pradera	1	0	0.00
5 Rancho de Las Flores	1	0	0.00
6 San Pablo	33	108	3.27
7 Santo Tomas	1	8	8.00
8 La Angostura	57	306	5.37
9 Hacienda El Paraiso	1	9	9.00
10 Hacienda Las Minitas	1	2	2.00
11 Las Lomitas	29	119	4.10
12 Guayaman	19	87	4.58
13 Santo Domingo No.2	19	118	6.21
14 Barranco Blanco	1	3	3.00
15 El Pital	2	5	2.50
16 Hacienda San Miguel	4	22	5.50
17 Suntul	5	33	6.60
18 Hacienda El Porvenir	17	82	4.82
19 Agua Caliente	6	7	1.17
20 Barrio Nuevo	30	172	5.73
21 Cerro Suntul	1	7	7.00
22 Comontan	23	73	3.17
23 El Cipres	10	43	4.30
24 El Potrero de S.F.	42	228	5.43
25 El Terrero del Guayabal	32	182	5.69
26 Hacienda San Lorenzo	1	7	7.00
27 Hacienda San Pablo	1	8	8.00
28 Hacienda San Vicente	3	6	2.00
29 Joya Grande	14	67	4.79
30 Loma El Romero	2	6	3.00
31 Llano de Maye	45	201	4.47
32 San Sebastian	3	21	7.00
33 Santiago	4	22	5.50
34 Santo Domingo No.1	24	96	4.00
Total	1,319	6,275	4.76

Source: Censo Nacional de Poblacion y Vivienda 1988

Table 3.3.3 LAND OWNERSHIP IN HONDURAS, INTIBUCA AND JESUS DE OTORO MUNICIPALITY (1974)

Ownership	Honduras		Distribution (%)	Intibuca Depart.		Distribution (%)	Jesus de Otoro		Distribution (%)
	Farms (No.)	Area (ha)		Farms (No.)	Area (ha)		Farms (No.)	Area (ha)	
Private	65,518	1,278,145	48.6	4,084	50,141	45.6	160	4,446	40.5
National	57,773	692,439	26.3	3,829	40,199	36.5	402	2,603	23.7
Rent	44,054	140,387	5.3	1,279	2,300	2.1	244	968	8.8
Other Forms	2,516	19,253	0.7	38	291	0.3	5	17	0.2
Private and National	6,031	257,634	9.8	217	6,916	6.3	37	1,774	16.2
Private and Rent	10,981	114,890	4.4	1,657	7,216	6.6	34	347	3.2
National and Rent	7,790	55,811	2.1	394	1,708	1.6	167	693	6.3
Private, National and Rent	678	71,300	2.7	23	1,232	1.1	10	135	1.2
Total:	195,341	2,629,859	100.0	11,521	110,003	100.0	1,059	10,983	100
Average Farm Size (ha)		13.46			9.55			10.37	

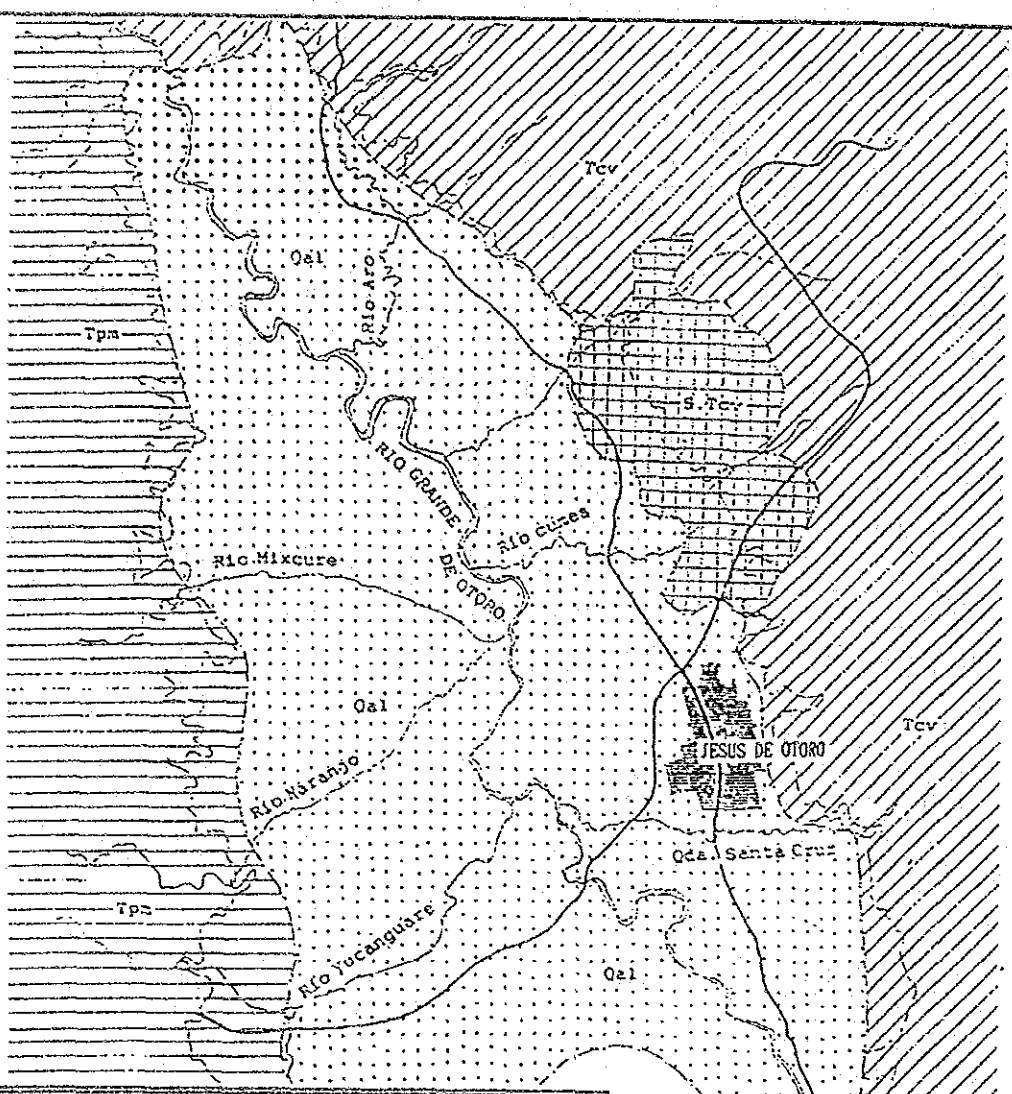
Source: Censo Nacional Agropecuario 1974

Table 3.3.4 FARMER ORGANIZATIONS IN JESUS DE OTORO MUNICIPALITY

	Name	Location	Year of Establi-shment	Members	Land Hold-ing Size in Manzanas
A	Groups at Reformed Sector				
1	E.A. Guayaman *	Guayaman	1982	31	408.0
2	E.A. Tatumbla *	Tatumbla	1976	10	45.0
3	E.A. Juan B. Montoya *	El Porvenir	1981	20	95.0
4	E.A. Ismael Cruz *	La Gloria	1985	14	40.0
5	E.A. Agricola	Santa Fe	-	17	105.0
6	E.A. Crucita Oriente *	Maye	1981	13	250.0
7	G.C. Ivan Betancourth *	La Gloria	1982	17	100.0
8	G.C. Maye *	Maye	1976	14	60.0
9	G.C. El Matazano	El Matazano	1972	20	70.0
10	G.C. Los Invencibles *	Maye	1984	12	25.0
11	G.C. Santa Fe	Santa Fe	1985	21	105.0
	Sub-total			189	1303
B	Groups at Non-reformed Sector				
1	Santo Domingo *	Santo Domingo	1990	14	50.0
2	Maye Independiente *	Maye	1988	18	69.0
3	San Marcos *	San Marcos	1988	16	60.0
4	El Esfuerzo *	J. de Otoro	1989	19	52.0
5	Santa Cruz *	Comontan	1989	16	75.0
6	Pro-Desarrollo	Coclan	1987	15	40.0
7	El Injerto	El Injerto	1989	23	100.5
8	Suyapa	Pastoza	1989	11	40.0
9	El Progreso	San Isidro	1990	16	175.0
10	Crucita Norte	Crucita Norte	1990	10	30.0
11	28 de Julio	San Antonio	1987	17	96.0
12	Productores Organizados	El Zapote	1988	8	54.0
13	Los Alpes	Los Alpes	1989	7	66.0
14	San Rafael	San Rafael	1988	25	178.0
15	14 de Junio	Santa Fe Arriba	1989	12	43.3
16	Macuelizo	Macuelizo	1990	16	50.0
17	El Eden	El Eden	1989	11	30.0
18	Lealtad *	Comontan	1990	15	30.0
	Sub-total			269	1,238.8

Source: (1) Agencia de Desarrollo Agropecuaio, Jesus de Otoro
(2) INA, Jesus de Otoro

Note: E.A. = Empresa Asociativa, G.C. = Grupo Campesino
* These groups are located in the Valle de Otoro.



	EXPLANATION
Qal	Recen t continental and marine sediments including talus deposits, gravel terraces, flood plain deposits,and alluvium.
Tpm	Padre Miguel Group: volcanic rocks consisting of pyrolasic rocks of the rhyolitic and andsitic suite,sedimentary rocks are derived from the volcanic rocks and flows of rhyolite, andsite,and basalt.
Tcv	Menber Cerro Verde. well hardened from gray reddish color to gray, and white containing biotite ,plagioclase, sanidine(?)and quartz.
S	Area of collapse or land sliding, showing the principal unit *included in rubbish.*

Fig. 3.2.1 GEOLOGICAL MAP

PROYECTO DE DESARROLLO AGRICOLA BAJO RIEGO EN EL VALLE DE OTORO

AGENCIA DE COOPERACION INTERNACIONAL DEL PAPOS (JICA)

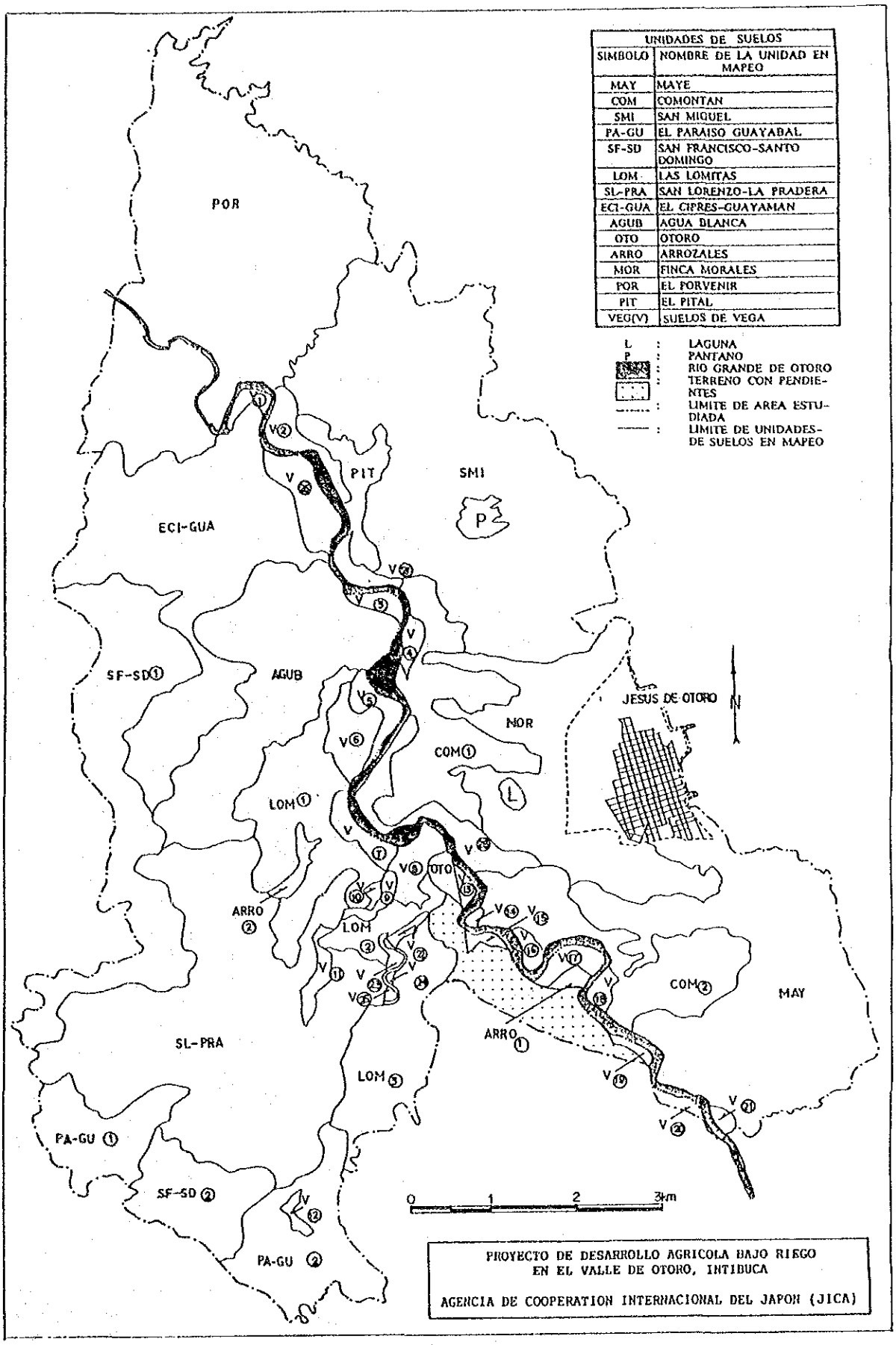


Fig. 3.2.2 MAP OF UNIT OF SOILS, THE JESUS DE OTORO VALLEY

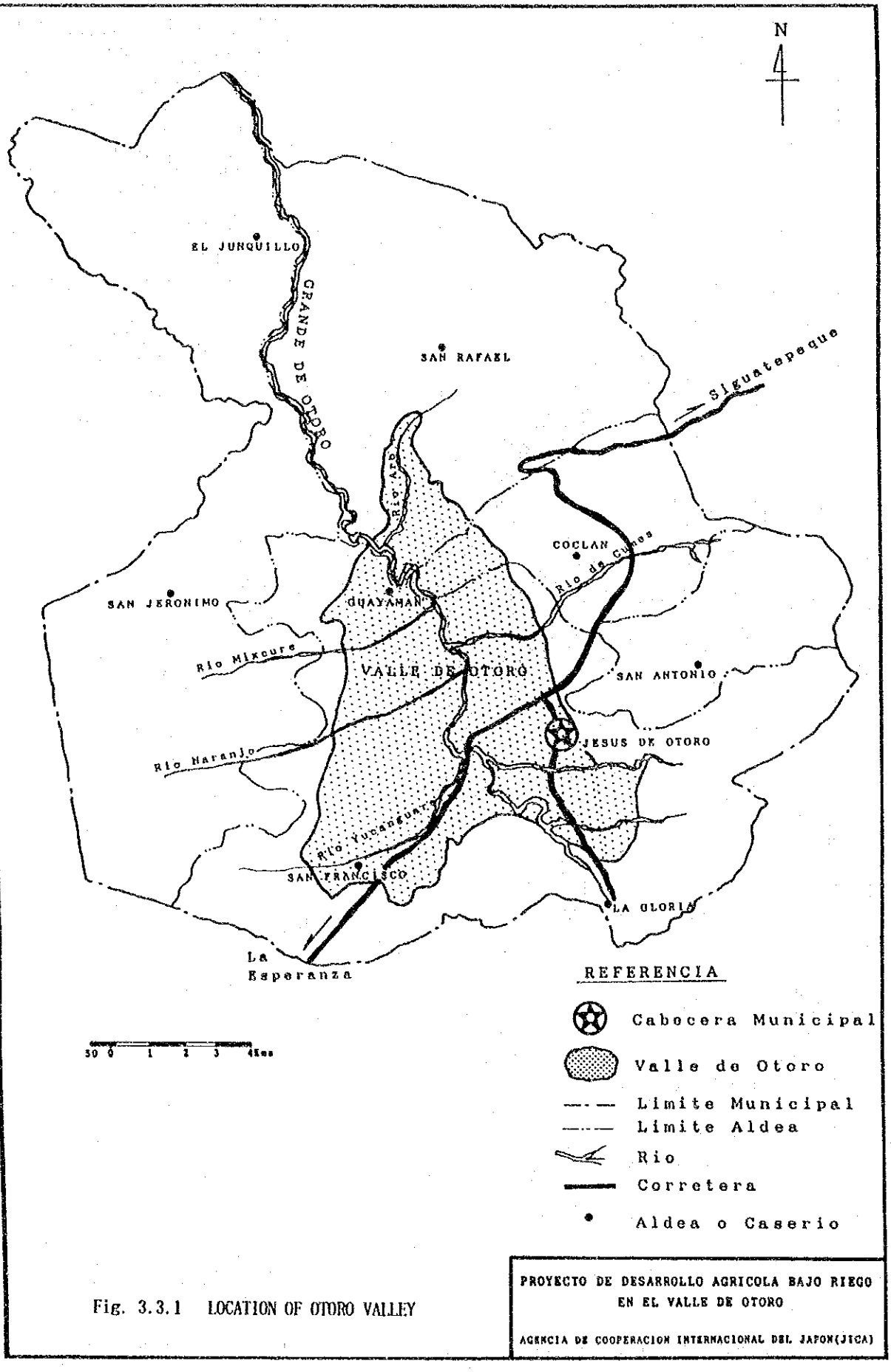


Fig. 3.3.1 LOCATION OF OTORO VALLEY

PROYECTO DE DESARROLLO AGRICOLA BAJO RIEGO EN EL VALLE DE OTORO

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON(JICA)

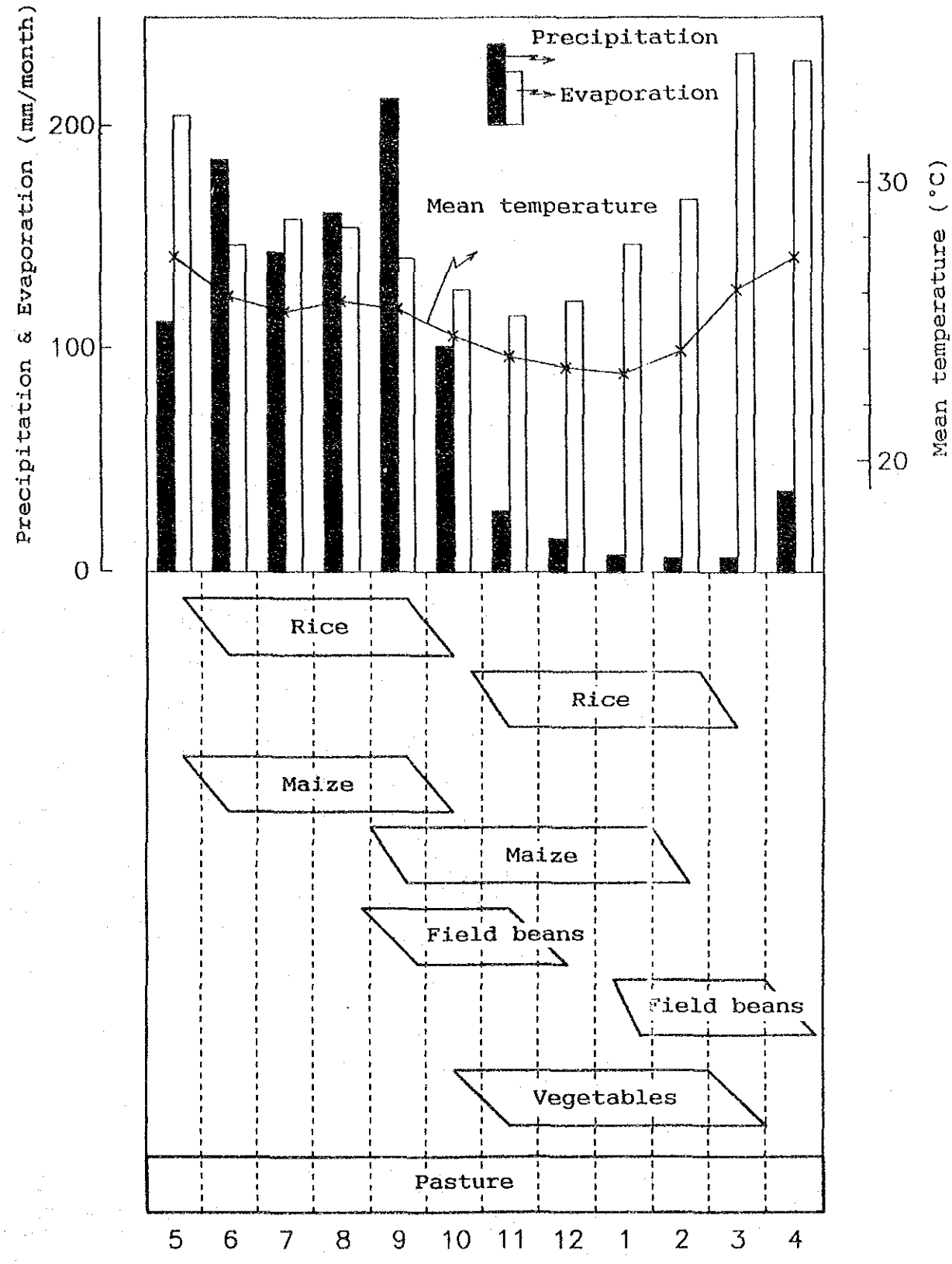


Fig. 3.4.1 Present Cropping Calendar

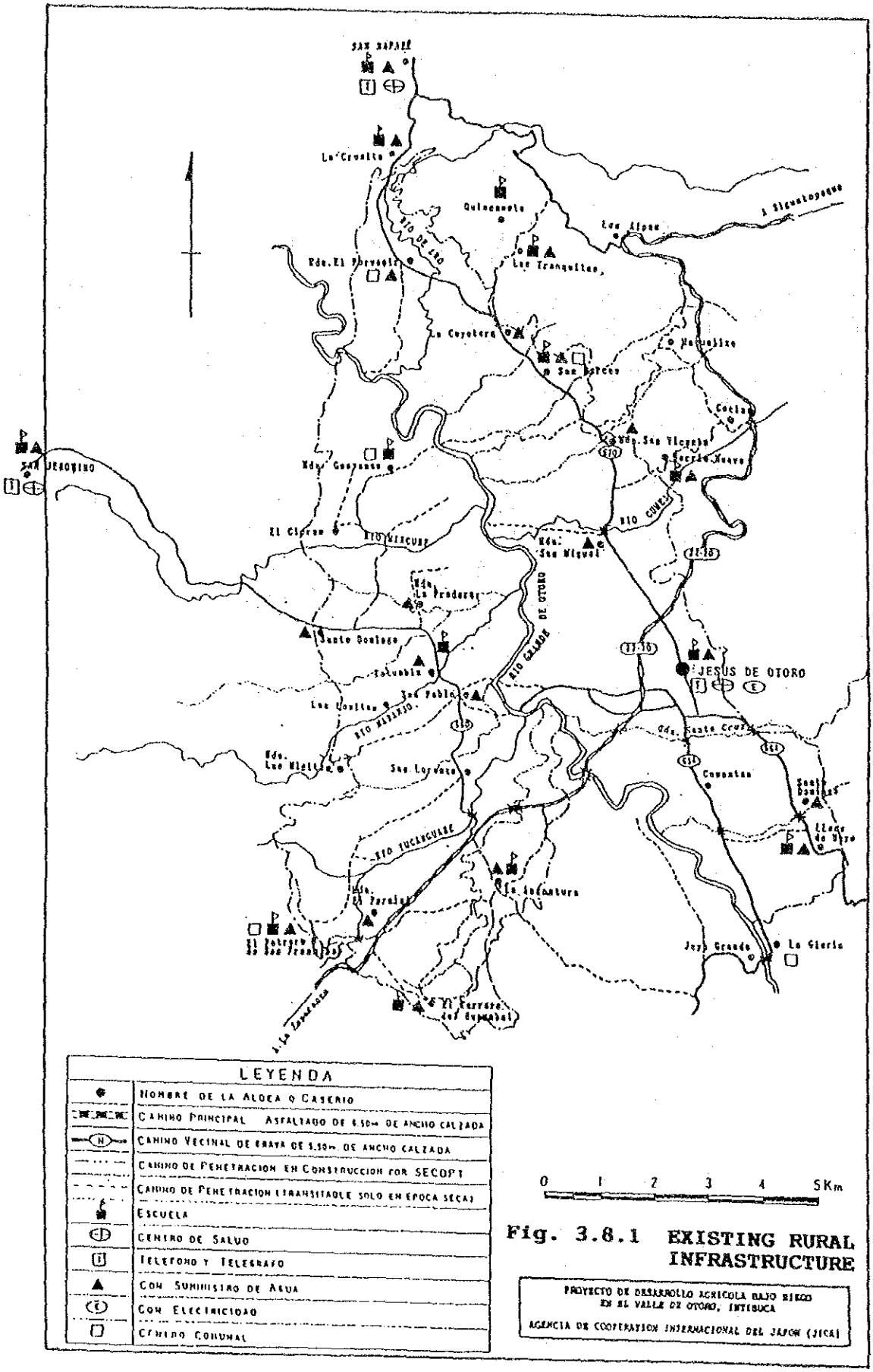


Fig. 3.8.1 EXISTING RURAL INFRASTRUCTURE

PROYECTO DE DESARROLLO AGRICOLA BAJO RIEGO EN EL VALLE DE OTORO, VERAGUAS
AGENCIA DE COOPERATION INTERNACIONAL DEL JAPON (JICA)

CHAPTER IV
BASIC DEVELOPMENT CONCEPT

CHAPTER IV BASIC DEVELOPMENT CONCEPT

4.1 Basic Irrigated Agricultural Development Concept

4.1.1 Necessity of the Project

A stable supply of the staple foods and improvement of income differentials between rural and urban areas are important policy in Honduras. The staple foods such as rice and maize are still not self-sufficient, and their consumption and import tends to increase every year. Establishment of their self-sufficient system is important and urgent. Jesus de Otoro municipality where the Study Area is included, produces 9% of the national rice production, being one of the important supplying place of staple foods (especially rice) in Honduras. Stable and increased production of the staple foods in the Study Area, therefore, would contribute much to the self-sufficiency of the food.

Reduction in income disparity between rural and urban areas is also an important and urgent policy. In the Study Area, only such grains that can easily be stored and are less damaged during transportation, have been produced due to bad road condition. Recently, however, main roads running through the Study Area have been improved, making it easier to transport agricultural products to large cities. Under such a situation, development of water resources in the Study Area including introduction of improved irrigation system would lead to the increased production of agricultural products such as basic grains and cash crops, thereby raising farmers' income.

4.1.2 *Factors That Impede Development*

Factors that impede the development are considered as follows;

(1) Poverty of Small Scale Farmers

The small scale farmers with landholding of less than 5 ha account for approximately 70% of whole farmers, while their lands cover only about 10% of the total farm land. It results income disparity between small scale and large scale farmers, and low level of income of small scale farmers is one of the main factors to impede the rural development.

(2) Underdeveloped Water Resources and Irrigation Facilities

Agricultural production is unstable because of underdeveloped irrigation facilities. Cash crops can not be introduced during dry season when root rot and diseases are less. It also results shortage of feeds for animals during dry season and impedes the development of livestock.

(3) Shortage of Agricultural Machinery

Shortage of agricultural machinery impedes timely plowing and seeding. The shortage of threshers increases threshing loss.

(4) Personnel and Material Shortage of Agricultural Extension Services

Existing staffs of agricultural extension services are active, but their efforts can not cover the whole area because of shortage of number of staff and vehicles.

(5) Inadequate Operation and Maintenance of Irrigation Facilities

As the existing irrigation systems were constructed and managed separately by individual persons or farmers' groups, irrigation systems are complicated and operation and maintenance are individually carried out. Such inadequate operation and maintenance result increase of water loss.

(6) Poor Feeder Road Conditions

Feeder roads in the Study Area are insufficient in density and maintenance, and vehicles can not drive during rainy season. It impedes timely transportation of agricultural inputs and products.

4.1.3 Basic Development Concept

(1) Basic Development Approach

Considering the national development plan, basic development approach was set up as follows:

1) Considering the national policy of food crops security, top priority is given to increase in the basic grains production.

2) In order to raise farmers' income in the Study Area, priority is also given to increase in cash crops production such as vegetables (tomato, cucumber, asparagus, etc.).

3) The water resources will be developed as much as possible with materializable scale from a point of funds. Irrigation will be basically planned with gravity system which is most easy in the operation and maintenance. Existing irrigation systems will be unified with a rational plan of irrigation facilities.

4) Rural development component such as improvement of roads and water supply, will be planned.

5) For successful project implementation, a farmer's organization plan will be formulated.

(2) Basic Development Concept

1) Irrigation plan

The water resources during dry season in the Study Area are divided into 74% of the Grande de Otoro River, 15% of the Yucanguare River, 2% of the Naranjo River, 2% of the Mixcure River, 5% of the Cumes River and 2% of the Aro River. The water resources of the

Grande de Otoro River, nevertheless, have not been developed in the area, although water resources of its tributaries have extensively been developed. At the formulation of irrigation plan, priority is given to the development of water resources in the Grande de Otoro River, and existing irrigated areas will be included into the new irrigation area of the Grande de Otoro River as much as possible. Existing irrigation areas scattered along the tributaries will be unified as much as possible, and the inclusion of un-irrigated farm lands along the tributaries will be studied if extra water resources is available.

2) Cropping pattern

The main objectives of the Project are to convert the production base of the Study Area into one of the major supplying bases of basic grains in Honduras and at the same time, to reduce income disparity in the Study Area by raising farmer's income. In order to achieve the objectives, introduction of improved cropping pattern would be necessary. Improvement of road conditions and introduction of modern irrigation system will enable farmers to introduce a wide selection of crops including such cash crops as vegetables. Under such a situation, basic grains will be planted during rainy season and cash crops like vegetables will be introduced during dry season. Irrigation for pasture land is also taken into account considering importance of livestock farming activities in the Study Area.

3) Rural infrastructure

In the formulation of farm roads development plan, management roads along the main canals will also be designed to be used as a part of farm roads network connecting villages and farms with main roads.

A water supply plan will be proposed if necessary, taking into consideration the existing facilities and a future plan of the concerned agencies.

Facilities necessary for promoting active farmer's organization will be proposed.

4) Farmer's organization

An organization plan necessary for smooth water management, and operation and maintenance of the irrigation systems will be formulated. Organization plan for marketing activities will be studied separately as well.

5) Implementation schedule of the Project

Implementation schedule of the Project will be formulated in accordance with priority of each irrigation system. The priority will be decided

according to such parameters as economic indicator (EIRR), number of beneficiaries, beneficial area, water resources conditions, easiness of construction, and accessibility. It should be noted, however, that the irrigation sub-project which will have to be implemented in advance from a point of framework of the Project will be preceded in spite of its priority. For example, if a tributary irrigation system is constructed before the implementation of the Grande de Otoro River irrigation system, a part of existing irrigation areas that belong to the service area of the Grande de Otoro River irrigation system will not be irrigated until the implementation of the same unless some countermeasures will have to be taken.

4.2 Formulation of Development Plan

4.2.1 General

It is proposed to develop the gravity irrigation systems for the irrigation plan in the Project Area, taking into account the following local conditions:

(1) There exist many irrigation systems in the Project Area. However, most of them have very simple structures and water utilization for irrigation is not efficient. Therefore, the plan will incorporate the existing irrigation areas, in order to make more effective use of the available water resources.

(2) The Grande de Otoro River is the only source of new exploitable water resources because most of the tributaries of the Project Area are already exploited. Therefore, the plan will give priority to the development of water resources of the Grande de Otoro River, and the surplus water produced as aresult of incorporation of existing irrigation areas to the Project, will be used to enlarge the irrigation areas in the tributaries basin.

(3) The plan will be designed basically to construct the year-round irrigation system. In order to make more efficient use of the land and water resources of the Project Area, supplementary irrigation system in the rainy season will also be examined. The existing command area in relation to the Santa Cruz Stream will not be included in the present plan as its flow drain out in the dry season.

4.2.2 Available Land and Water Resources

(1) Developable Areas

As a resut of the soil investigation, it has been estimated that within the total area of 8,100 ha in the Study Area, the land suitable for irrigated agriculture are 6,000 ha (excluding the Santa Cruz Stream basin). The distribution of the areas for each basin is summarized in the following table. It must be pointed out that the land suitable for agriculture development in the Grande de Otoro basin is located at an elevation under 600m.a.s.l.

Basin	Suitable Land (ha)
Grande de Otoro	2,722 (884 at right bank 1,838 at left bank)
Yucanguare	1,022
Naranjo	394
Mixcure	426
Cumes	792
Aro	629
Total	5,985

(2) Water Resources

The exploitable water sources for the planned agriculture development comprise the Grande de Otoro River and their tributaries, whose basin area totals 1,484 sq km. Being the areal rainfall of these basin of 1,323 mm and the mean runoff coefficient in La Gloria station of 0.48, for an average year the total discharge in all the basin amounts approximately to 940 MCM (millions of cubic meters).

The arable land within the Rio Grande de Otoro basin and its tributaries is located in general at the elevation of under 700 m.a.s.l. Therefore, it is considered that above this elevation are located the recharge zone of the water sources. Based on the results of specific discharge in La Gloria station and area of recharge zone of the main river and the tributary basins, the exploitable water volume has been estimated as shown below.

Basins	Water Sources Recharge Zone (sq km)	Avergae Year (MCM)	Proba bility of ex- ceedance Year (MCM)	Proba- bility of non- exceedance Year (MCM)
Grande 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
Cumes	27.5	18.61	26.58	16.80
Aro	24.9	16.85	24.07	15.21
Total	1,068.5	723.14	1,032.70	652.89

4.2.3 Analysis of Water Sources Development

In exploiting new sources of water in the tributaries, due consideration would be necessary to protect the existing water rights, specially in the dry season, because at present there are

any facilities of simple structures are already constructed taking advanrage of suitable topographical conditions.

On the other side, the construction of dams which allow to store the surplus water during rainy season in these tributaries would be difficult due to the topography which shows steep gradient of the bed and the alluvial fan. In this way the exploitation of the water resources of the Grande de Otoro River, whose discharge is plentiful even in dry season, acquire prime importance for the development of new water sources.

Although the existing irrigation areas in the tributaries basins totals about 3,000 ha, the systems are very simple. In the dry season, they can irrigate only one sixth of the area that can be irrigated during the rainy season. Therefore it would also be indispensable to exploit the tributaries with reliable flow in order to make effective use of the resources.

As was previously described, the water sources for the irrigation of the Jesús de Otoro Valley would be the Grande de Otoro River and the five tributaries. At present, rainfall data are observed only at the Grande de Otoro River. Although no record of rainfall is available in the tributaries, the lacking informations could be obtained from the record at the grande de Otoro, considering that the discharge of the tributaries is highly correlated with the discharge of the Grande de Otoro River observed in La Gloria Station. In this way, for the rest of the tributaries the equivalent discharge has been calculated to the year with probability of non-exceedance of 5 years against the specific discharge of the Grande de Otoro River, whose results are summarized in Table 4.2.1.

The exploitable discharge for the Project would be the difference between the above mentioned water resources and; (1) the available volume of water in the existing areas under irrigation which are not included in the Project and (2) the maintenance water for the river conservation.

In the following table the exploitable discharge for the sources is summarized:

Unit: m3/s

	Otoro	Yucan-guare	Naranjo	Mixcure	Cumes	Aro
Jan.	5.073	0.965	0.142	0.109	0.271	0.173
Feb.	4.237	0.817	0.117	0.099	0.225	0.144
Mar.	3.677	0.725	0.123	0.102	0.230	0.125
Apr.	4.456	0.879	0.149	0.124	0.279	0.152
May.	3.789	0.569	0.066	0.042	0.131	0.105
Jun.	12.046	2.327	0.366	0.292	0.692	0.410
Jul.	13.965	2.634	0.374	0.281	0.719	0.476
Aug.	14.792	2.769	0.380	0.279	0.735	0.504
Sep.	37.231	7.260	1.182	0.965	2.225	1.268
Oct.	27.864	5.483	0.923	0.766	1.728	0.949
Nov.	21.309	4.177	0.964	0.572	1.301	0.726
Dec.	6.289	1.212	0.188	0.150	0.357	0.214

4.2.4 Analysis of the Development Area

(1) Exploitable Area According to the Water Sources

The exploitable areas calculated based on the available discharge and the proposed cropping pattern are:

Unit: Gross Area in Ha

Sources	Cultivation Dry Season	Cultivation Rainy Season	Suitable Lands (ha.)
Grande de Otoro	5,524	27,291	2,722
Yucanguare	1,057	5,109	1,022
Naranjo	156	646	394
Mixcure	120	434	426
Cumes	309	767	792
Aro	188	930	629

(2) Delineation of the Development Areas

Selection of the development areas has been made based on the result of the exploitable areas according to the water resources as mentioned in the preceding section.

In the case of Grande de Otoro River, it would be necessary to elaborate a plan which propose to create intake facilities for each side, because the alternative study has indicated that the plan to irrigate the area from one intake facility would involve higher cost due to unfavorable topographical conditions.

In the case of Yucanguare River, the topography of the basin upstream is complex, because at 5.3 km. upstream of the confluence with Grande de Otoro River, is the confluence with Quila Stream, which enter from left side, showing a configuration which make difficult the supply of irrigation water towards the left side. Therefore, it is proposed to install independent intake facilities for each side for economic and technical reasons.

For the rest of the rivers it is proposed to irrigate both sides from one intake.

Therefore, the area of the present Project will be divided into the following eight subprojects which will use the water resources from 6 sources:

Water Source	Name of Sub-Project Area
Grande de Otoro River:	1. Grande de Otoro, Left Bank 2. Grande de Otoro, Right Bank
Yucanguare River:	3. Yucanguare, Right Bank 4. Yucanguare, Left Bank
Naranjo River:	5. Naranjo
Mixcure River:	6. Mixcure
Cumes River:	7. Cunes
Aro River:	8. Aro

4.2.5 Study of the Optimum Development of Irrigation

(1) Irrigation Subprojects and their Alternatives

In order to optimize the dimension of development, an irrigation plan has been elaborated so as to maximize the beneficiary areas, based on the results of the exploitable areas and the topographic conditions.

Several alternative plans have been examined for the right bank area of the Grande de Otoro. The study included the comparison between the alternatives of constructing the intake facilities at differents heights: up-, medium- and down-streams, respectively. This is due to the large difference of elevation between the river bed and the farm land in the part of middle and upper reacheds of the river which would invlove a large scale of construction works.
The limited water resources from such rivers as the Naranjo, Mixcure and Cumes make it difficult to formulate the year-round irrigation plan for the whole of the corresponding irrigation area. Therefore, two alternatives have been examined: (1) a plan of year-round irrigation in the limited area, and (2) a plan of supplementary irrigation in the rainy season, while in the dry season it would give maximum use of the available water volume.

As a result of alternative study as mentioned above, the irrigable areas of each sub-project have been determined as shown in the following Table. These areas have been delineated taking into account topographical as well as soil conditions.

Unit: ha.

Rivers	Irrigation Area (Gross)	(Net)	Alt.1	Alt.2	Alt.3
Grande de Otoro:					
Left bank (with intake at medium)	950	760	760	----	----
Right bank (with intake at upstream)	672	538	538	----	----
(with intake at medium)	410	328	----	328	----
(with intake at downstrean)	284	227	----	----	227
Yucanguare:					
Right bank	460	368	368	----	----
Left bank	215	172	172	----	----
Naranjo:	375	300	156	*300	----
Mixcure:	538	430	120	*430	----
Cumes:	447	358	309	*358	----
Aro:	90	72	72	----	----

Note:

- The irrigation intensity of the areas marked with asterisk (*) are the following:

Naranjo: 100% in rainy season and 52% in dry season
Mixcure: 100% in rainy season and 28% in dry season
Cumes: 100% in rainy season and 86% in dry season

- Those which have no mark have the intensity of 100% in rainy as well as dry season.

(2) Estimated Costs for Alternative Study

The calculation of the estimated costs of each plan of the sub-project areas and the respective alternative is based on the unit prices of the projects of DGRH which were executed in the past or planned to be executed.

One of the important criteria in the evaluation of the alternatives is the cost of development per hectare (against total cultivated area), supposing that the benefit and the operation and maintenance costs are equal.

As a resut of the study, the lowest unit cost of construction has been indicated in the Alternative 3 of the Grande de Otoro, Right Bank (intake site at downstream) and the Alternative 2 of the Naranjo, Mixcure, and Cumes (which consist of supplementary irrigation in the rainy season, and maximum use of the available water volume in the dry season).

Construction Cost per Hectare

Unit: Thousand Lempiras

Name of Sub-Project Area		Construction Cost
1. Grande de Otoro River, Left bank		22.2
2. Grande de Otoro River, Right bank	Alt.1	53.4
	Alt.2	169.6
	Alt.3	29.8
3. Yucanguare, Right bank		13.0
4. Yucanguare, Left bank		21.2
5. Naranjo	Alt.1	20.3
	Alt.2	16.8
6. Mixcure	Alt.1	37.0
	Alt.2	21.4
7. Cumes	Alt.1	18.3
	Alt.2	17.6
8. Aro	Alt.1	31.7

4.2.6 Optimum Development Scale

As a consequence, the proposed Project will consist of eight sub-projects with the areas to develop and irrigate according to the rainy and dry season as detailed in the following table:

Sub-Project	Development Area	Irrigation Area	
	(Gross)	Rainy Season	Dry Season
Grande de Otoro, Left bank	950	950	950
Grande de Otoro, Right bank	284	284	284
Yucanguare, Right bank	460	460	460
Yucanguare, Left bank	215	215	215
Naranjo	375	375	195
Mixcure	538	538	150
Cumes	447	447	386
Aro	90	90	90

For each area of the eight subprojects, the irrigation systems network has been formulated. Each network of irrigation canals was designed in such a way that the area under irrigation can be maximized according to the topography and the actual land use, using the existing topographical maps. Fig. 4.2.1 shows the Distribution of Irrigation Canals and in Fig. 4.2.2 the Schematic Diagram of the Proposed Irrigation System Network.

TABLE 4.2.1 RIVER DISCHARGE IN DROUGHTY YEAR

UNIT :m3/sec

RIVER NAME		OTORO	YUCANGUARE	NARANJO	MIXCURE	CUMES	ARO
JAN	1	6.380	1.258	0.213	0.178	0.399	0.217
	2	6.790	1.339	0.227	0.189	0.425	0.231
	3	5.340	1.053	0.179	0.149	0.334	0.182
FEB	1	4.570	0.901	0.153	0.127	0.286	0.156
	2	4.460	0.879	0.149	0.124	0.279	0.152
	3	4.760	0.939	0.159	0.133	0.298	0.162
MAR	1	4.180	0.824	0.140	0.116	0.261	0.142
	2	3.870	0.763	0.129	0.108	0.242	0.132
	3	4.570	0.901	0.153	0.127	0.286	0.156
APR	1	5.730	1.130	0.192	0.160	0.358	0.195
	2	5.120	1.010	0.171	0.143	0.320	0.174
	3	4.690	0.925	0.157	0.131	0.293	0.160
MAY	1	3.310	0.653	0.111	0.092	0.207	0.113
	2	3.240	0.639	0.108	0.090	0.203	0.110
	3	5.390	1.063	0.180	0.150	0.337	0.184
JUN	1	12.680	2.500	0.424	0.353	0.793	0.432
	2	21.580	4.255	0.722	0.601	1.350	0.735
	3	16.850	3.322	0.563	0.470	1.054	0.574
JUL	1	23.130	4.561	0.773	0.645	1.447	0.788
	2	25.530	5.034	0.854	0.711	1.597	0.870
	3	14.700	2.898	0.492	0.410	0.919	0.501
AUG	1	37.480	7.390	1.253	1.044	2.344	1.277
	2	15.570	3.070	0.521	0.434	0.974	0.530
	3	28.580	5.635	0.956	0.796	1.788	0.973
SEP	1	59.770	11.785	1.999	1.666	3.738	2.036
	2	39.190	7.727	1.311	1.092	2.451	1.335
	3	57.150	11.269	1.911	1.593	3.575	1.947
OCT	1	69.690	13.741	2.330	1.942	4.359	2.374
	2	42.340	8.348	1.416	1.180	2.648	1.442
	3	29.330	5.783	0.981	0.817	1.834	0.999
NOV	1	24.870	4.904	0.832	0.693	1.556	0.847
	2	32.120	6.333	1.074	0.895	2.009	1.094
	3	22.430	4.423	0.750	0.625	1.403	0.764
DEC	1	17.780	3.506	0.595	0.495	1.112	0.606
	2	11.470	2.262	0.384	0.320	0.717	0.391
	3	6.620	1.305	0.221	0.184	0.414	0.225

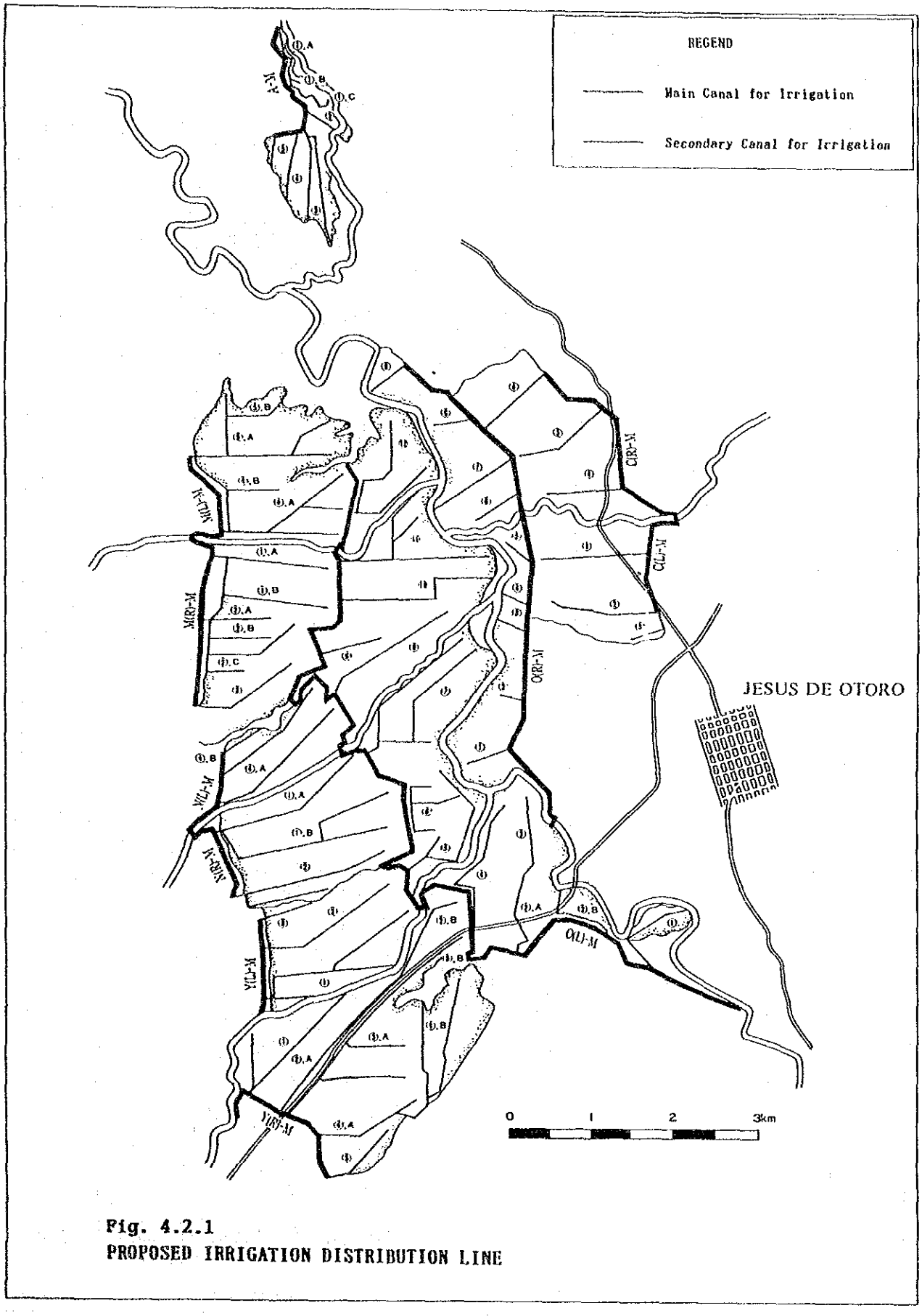


Fig. 4.2.1
PROPOSED IRRIGATION DISTRIBUTION LINE

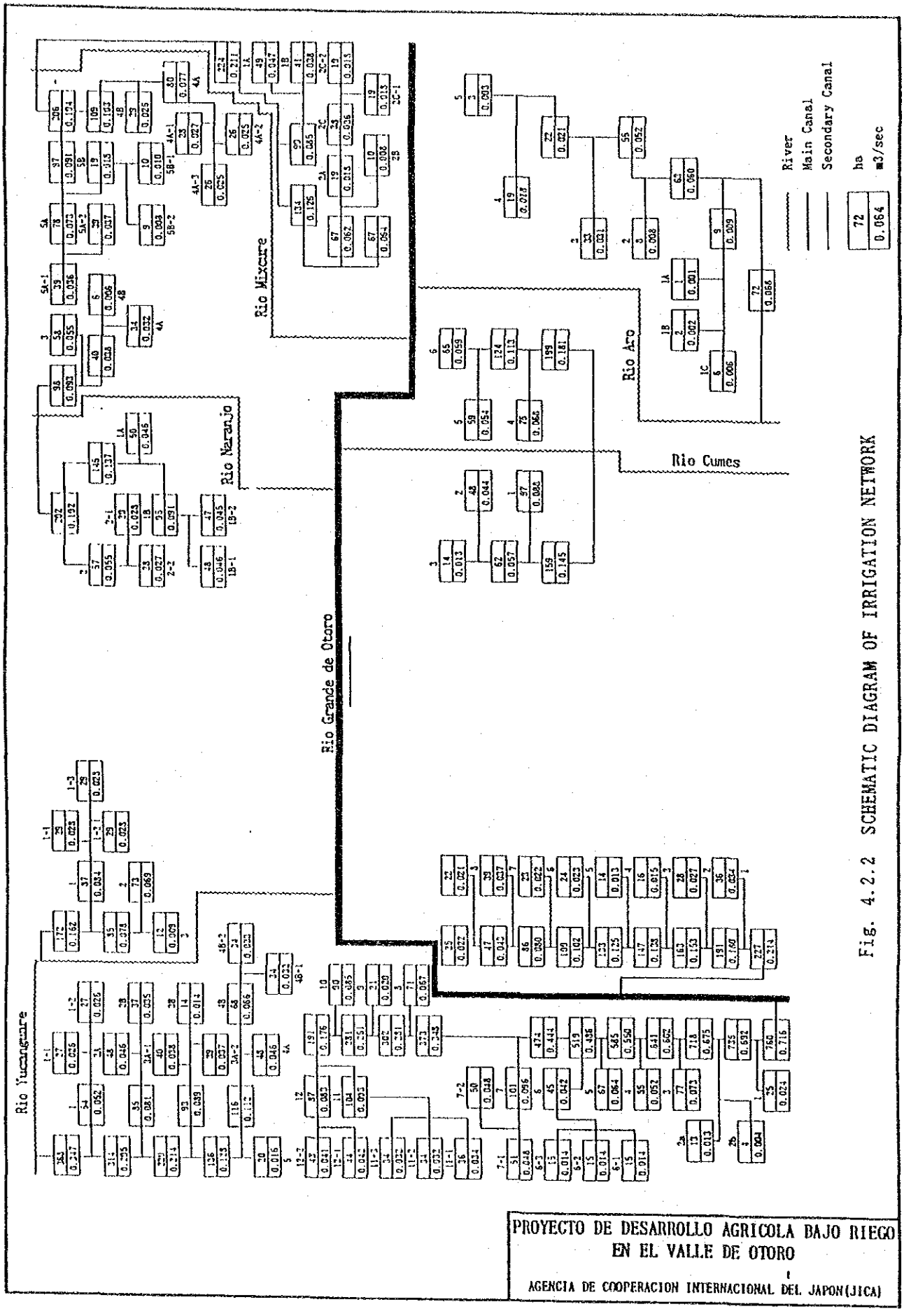


Fig. 4.2.2 SCHEMATIC DIAGRAM OF IRRIGATION NETWORK

CHAPTER V
DEVELOPMENT PLAN

CHAPTER V DEVELOPMENT PLAN

5.1 Agricultural Development Plan

5.1.1 Land Use Plan

(1) Features of Land observed from the Viewpoint of Soil Properties

It is assumed that the land forming "Velle de Otoro" has been closely influenced with geography of the surrounding hills. The present land might be formed by sedimentation of mud flow from the hills and the succeeded upheaval. A part of lands in the valley has high potentialities for agricultural productivity. Its feature may be summarized as follows:

a. Topography is almost flat.
b. Effective soil profile is considerably deep.
c. Both gravel and stones are few in soil horizon and on land surface.

However, a part of lands has problem points as follows:

a. Effective soil profile is shallow.
b. Moisture content of soils is deficient, while drainage in soil layers is imperfect.
c. A much amount of gravel and stone exist in soil horizon and land surface.

(2) Landholding and Size of Farm Land

n general, the possessive form of land and the size of individual field closely relate to planning of land use. Therefore, in the case that any plan of land use is made, a consideration towards the possessive form of land and the size of individual field is necessary.

(3) Relation between Soil Properties and Cultivatable Crops

Among the various conditions which are needed for planning of land use, the relation between soil properties and cultivatable crops was investigated. The result obtained was shown in Table 5.1.1 and, furthermore, the detail was given in Paragraph 2.4 in Annex B.

(4) Relation between Irrigation Development and Land Use Plan

The proposed area to be put under irrigation development is 3,359 ha out of 8,140 ha in the Study Area. The break down is as follows: 1) Left bank area of the Rio Grande de Otoro (950 ha); 2) Right bank area of the Yucanguare (460 ha); 3) Left bank area of the Yucanguare (215 ha); 4) Both banks area of the Naranjo (375 ha); 5) Both banks area of the Mixcure (538 ha); 6) Right bank area of the Rio Grande de Otoro (284 ha); 7) Both banks area of the Cumes (447 ha); and 8) Left bank area of the Aro (90 ha).

If irrigation development is carried out, the present land use will be changed naturally.

It is assumed that the present land use for crop production (planted areas of 832 ha of rice, 282 ha of upland crops and 712 ha of grass) will change to 1,325 ha, 1,057 ha and 305 ha, respectively after the implementation of the Project. The detailed description is given in Table 2.1.1 and Figure 2.1.1 in Annex B.

5.1.2 Cropping System

(1) Crop Selection

Crop selection is carried out based on the following information:

1) Soil and climate: Crops cultivated in Comayagua will be selected due to similar climate
2) Marketability: To introduce marketable crops
3) Techniques and experience of farmers: Information can be easily obtained from farmers surrounding in Otoro City.
4) Wishes of farmer: According to Farm economy survey and interview with farmers, farmers wish to extend rice cultivation and plant vegetables and orchards that generate large cash income, that is if irrigation and drainage facilities are introduced.

Crops suitable to the Study Area are as follows:

Crops for local market:

Rice, maize, Field beans, Young field beans, Tomatoes, Onions, Cucumbers, Cushaws, Eggplant, Young peas, Melons, Chili,

Crops for exportation:

Baby corn, Onions, Cucumbers, Cushaws, Eggplant, Okras, Tomatoes, Young peas, Squash

(2) Cropping System

Crops will also be planted in the dry season to increase land use efficiency after construction of irrigation facilities, a situation that would considerably increase pest and disease incurred damages. In Comayagua where irrigation has been implemented the widespread of white flies is observed causing serious damages to tomatoes and other vegetables. The widespread of pests and diseases is also expected in the Study Area as crops will be cultivated all year round as a result of the completion of irrigation facilities. However, the increase in damages can be prevented by implementing proper cropping periods and field management which could also contribute to the reduced usage of agrochemicals.

FHIA (Fundacion Honduras de Investigacion Agricola) recommended a new cultivation method that would reduce damage by white flies, which is plentiful in Comayagua Valley. The varietal tests on tomatoes was carried out in 1992-93 by the recommended cultivation method. Test showed a number of good yielding varieties and lines, more tests should be carried out to confirm the results which were only derived from one test (Metodologia para cultivar del tomatoes para proceso en el valle de Comayagua (Hobduras) bajo la limitante de la mosca blanca, 1993 FHIA).

The cropping system is indicated in Figure 5.1.1.

5.1.3 Cultivation Method Plan

The required manpower, capital and agricultural materials and revenues expected based on the planned method of cultivation are shown in table ANNEX D. 4.2.1.

5.1.4 Anticipated Yield and Production

The anticipated yield, which is examined based on the information indicated in Table 4.3.2, ANNEX D, is shown below.

Average yield, cultivated area and production at present

Crops	Yield t/ha	Cultivated Area ha (A)	(B)	Production ton (A)	(B)
Rice					
Rain-fed	3.00	158	123	479	373
Irrigated (a)	3.50	1,287	490	4,505	1,715
Irrigated (b)	4.00	587	221	2,293	882
Irrigated (c)	6.00		1,325		7,950
Irrigated (d)	7.00		865		6,057
Maize					
Rain-fed	1.40	599	554	827	765
Irrigated (a)	2.20	274	37	603	81
Irrigated (b)	2.50	49	22	122	55
Irrigated (c)	4.00	-	1,040	-	4,158
Irrigated (d)	-		-		-
Field beans					
Rain-fed	0.70	335	310	248	-
Irrigated (a)	0.90	153	21	135	18
Irrigated (b)	1.00	10	4	9	4
Irrigated (c)	-		-		-
Irrigated (d)	1.50	-	216		324
Tomatoes					
Irrigated (b)	8.70	12	-	100	-
Irrigated (d)	29.00				

a: present irrigation area in rainy season;
b: present irrigation area in dry season;

c: proposed irrigation area in rainy season;
d: proposed irrigation area in dry season.

Presently a fair amount of agricultural inputs are applied in the Study Area and crops yields are comparatively high. Yields are expected to increase moreover after completion of the proposed irrigation facilities.

5.1.5 Labor and Agricultural Machinery

The monthly labor requirement under the proposed Project is shown below (See ANNEX D, Table 4.4.1 for details).

Monthly Labor Requirements per month
after completion of irrigation facilities

Crops	Area (ha)	5	6	7	8	9	10	11	12	1	2	3	4
Rice(1)	1,938	41,707	36,146	13,902	8,341	55,610	0	0	0	0	0	0	0
Rice(2)	1,086	0	0	0	0	0	23,372	20,255	7,791	4,674	31,162	0	0
Field bean(2)	221	0	0	0	0	0	0	6,659	5,390	3,171	0	0	0
Maize(1)	1,631	0	2,3400	37,440	4,580	0	0						
Vegetables(2)	837	0	0	0	0	0	7,205	47,270	60,698	26,801	33,410	12,559	
Laborers Total		41,707	59,547	51,343	13,022	55,610	30,577	92,904	73,879	34,646	64,572	12,559	
Family labor	2,895	89,745	86,850	89,745	89,745	86,850	89,745	86,850	89,745	89,745	81,060	89,745	
Hired labor	2,812	87,172	84,360	87,172	87,172	84,360	87,172	84,360	87,172	87,172	78,736	87,172	
Surplus labor		135,210	111,663	125,574	163,895	115,600	146,340	78,306	103,038	142,271	95,224	164,358	

(1): rainy season, (2): dry season

The number of farm households in the Study Area is 965, therefore, it is calculated that a work force of 86,850 can be available monthly as each of the households hold at least 3 capable family members (see ANNEX E 4). However with vegetable cultivation, reliance on family labor alone will not suffice due to the various work involved, e.g. nursery construction, seeding, transplanting, support construction, etc.. The Study Area has a work force of 2,812/day and 86,360/month, a number that will not encumber the cultivation of vegetables on 837 hectares of land. This situation is expected to guarantee increase in job opportunities.

(2) Agricultural machine

1) Tractor

Most rice and maize crops are seeded simultaneously right after the onset of the rainy season in May, due to shortage in irrigation facilities and the dependence on the unstable rainy season. Plowing is done by the eleven tractors owned by the farmers, the two tractors owned by the Esperansa Office of the Ministry of Natural Resources and by two oxen owned by the farmers.

According to the recommended cropping system, rice will be seeded in May, the rainy season, maize will be seeded in June, the dry season, rice will be planted in October, then vegetables and field beans will be planted in November. Number of tractors needed in this seeding period will be reduced to 3.2 i.e. from 19.3 in the present cropping system, and 16.1 in the recommended cropping system, on the assumption that the present seeding period is carried out within one month which is the same as the recommended cropping system (see below table).

Number of tractors needed
for completion of plowing within one month

Crops	Season	Outside of Irrigated Area	Irrigated Area		Total Study Area	
		Present	Present	Plan	Present	Plan
Rice	Rainy	5.1	6.9	11.0	12.0	16.1
	Dry	1.8	2.9	7.2	4.8	9.0
Maize	Rainy	4.9	2.4	8.7	7.3	13.6
	Dry	0.2	0.2	0.0	0.4	0.2
Field bean	Rainy	-	-	-	-	-
	Dry	-	-	1.8	0.0	1.8
Vegetables	Rainy	-	-	-	-	-
	Dry	-	-	7.0	0.0	7.0
Total	Rainy	10.0	9.3	19.7	19.3	19.7
	Dry	2.0	3.2	16.0	5.2	18.0

It can not be expected much of the two tractors owned by the Esperansa Office of the Ministry of Natural Resources, which are never available at the period the farmers need them.

Area plowed by two oxen will decrease from 758 ha actually to 449 ha. However, since the cultivated area will extend up to 1,251 ha in the rainy season, and to 837 ha in the dry season, the area furrowed by the two oxen will increase. This will therefore not affect adversely the farmers' income.

2) Thresher

Rice threshing in the Study Area is carried out using either seven threshers moved by tractor engine, or man power only. The working capacity for threshing as below:

Working capacity for threshing processes

Item	Working ability
Reaping	11.5 man/ha/day
Carrying	14.3 man/ha/day
Threshing	8.6 man/ha/day
Thresher	4.5 ton/day

Rice production and number of threshers needed for a one-month threshing period are as below.

Season	Outside the Irrigated Area	Irrigated Area		Total Study Area	
	Present	Present	Plan	Present	Plan
		Production (ton)			
Rainy	2,088	2,896	7,950	4,983	10,038
Dry	882	1,411	6,057	2,293	6,939
		Number of threshers			
Rainy	15	21	59	37	74
Dry	7	10	45	17	51

Rice threshed by threshers per month presently amounts to 945 tons, and the residual 4,055 tons of rice are threshed by man power. The average yield 3.6 t/ha of rice, is threshed by 8.6 workers a day, which means that threshing daily requires about 1,100 workers.

Rice production is expected to increase from 5,000 to 10,000 tons in the rainy season, and from 2,300 to 7,000 tons in the dry season. 1,755 tons of rice will be monthly threshed by threshers, on the assumption that six additional threshers will be introduced and used with the remaining seven tractors. Further 500 supplementary workers will be needed to thresh the remaining 8,245 tons, on the assumption that the average yield of rice, 5.6 ton/ha, will daily requires 13.3 workers for threshing. These workers will be hired in the Study Area where labor force is 2,812.

5.1.6 Postharvest Processing and Storage

(1) Postharvest Processing

A proper postharvest processing such as protection of agricultural inputs and preservation of crop quality shall be regarded as very important to improve the economical value of crops and to increase farmers' income.

1) Grains

The price of rice is beaten down by the rice mill, as the average amount of cracked rice kernel represents about 25 percent, sometimes 100 percent (interviews of farmers). Cracked rice kernels result from bad drying process after harvest. Moisture content of rice after harvest usually ranges between 20 and 30 percent, and optimal moisture content when carrying out hulling is approx 15 percent. This is why wrong drying process (rapid drying) or sudden moisture absorption cause cracked rice kernels.

When dry rice is directly piled on the land after being reaped, moisture content of rice rises because rice absorbs water from the soil. This is another cause of cracked rice

kernels.

It is difficult to control sun-drying process of rice. It takes a few hours to reduce moisture content of rice in fine whether. On the other hand, it takes a few days in cloudy whether with high humidity.

When rice is sun-dried, rapid drying shall be avoided and attention must be paid, therefore, to the period of time required for optimal drying of rice, which differs very much when rice dried on concrete, nylon or canvas sheets.

When rice is dried with a dryer, cracked rice kernel is due to: (a) high moisture content of rice at drying, (b) drying in a short time at high temperature. To prevent rice from cracking, rice will be kept for one day to make moisture content uniform after first drying, then it will be dried again. Paddy rice with a moisture content exceeding 25 percent before drying is said to be of poor gustatory quality, therefore, moisture content shall be checked. To avoid deterioration of rice quality, rice will be dried at low temperature by 25 percent of its moisture content then dried at high temperature.

2) Vegetables

Storage and transportation of vegetables, especially long-term storage, are difficult because vegetables are living and continue to respire and transpire even after harvest. One should consider the series of farm practices involved in the vegetable production, because selection of varieties, cultivating conditions, control of pests and diseases, contamination by agrochemicals, influence very much the quality of vegetables especially for storage and selling. Optimal storage temperature, humidity and storage period of each vegetables are shown in ANNEX D Table 4.5.1.

Information and knowledge on postharvest processing and export of vegetables are available at FHIA.

(2) Storage

1) Grains

Rice will be sold as paddy rice, and temporarily stored in a warehouse before selling. Moisture content of stored rice shall be adjusted and be less than 15 percent, whether rice is stored in bulk or in pack.

2) Vegetables

Vegetables will not stored in the Study Area, but will be shipped according to the distributors' demand.

5.1.7 Future Farm Management in the Irrigation Scheme

Production cost and income per hectare for selected crops are calculated and shown below (see ANNEX D, Table 3.8.1).

Production cost and income (Lps/ha)

Crops	Cost				Income	Profit	Profit ratio
	Labor	Machinery	Material	Total			
Rice	803	1,363	1,287	3,453	8,460	5,007	2.45
Pea (yang)	2,066	459	1,711	4,236	60,258	56,022	14.22
Egg plant	2,095	918	2,219	5,232	27,547	22,314	5.26
Onion	2,339	846	1,841	5,026	35,007	29,981	6.97
Chili	2,382	846	2,327	5,555	32,057	26,502	5.77
Field bean	689	516	464	1,669	1,653	-16	-
Field bean (yang)	2,152	918	1,590	4,660	15,466	10,806	3.32
Baby corn	1,291	502	1,436	3,230	43,989	40,759	13.62
Maize	717	502	1,542	2,761	4,409	1,648	1.60
Okra	976	918	3,027	4,921	24,103	19,182	4.90
Cucumber	2,941	918	1,435	5,294	340,890	335,595	64.39
Squash	2,224	846	2,023	5,094	27,116	22,023	5.32
Tomato	2,296	918	1,649	4,863	17,217	12,354	3.54
Cushaw	2,224	846	2,006	5,076	18,077	13,001	3.56

To recover the low benefit production of staple foods such as maize and particularly field beans, the ratio of family labor for these products shall be increased. The surplus staple foods will be sold, once the demand will be met in the Study Area. On the other hand, benefit from vegetables is large, but the annual fluctuation of prices is very sharp and, besides, vegetables can not be preserved as long as grains. Therefore, it is important to select proper vegetable species before seeding, which can be sold in fixed quantity to the distributors.

5.1.8 Animal Husbandry

(1) Management of Pasture

Otoreño I (*Andropogon gayanus*) will be introduced into the Study Area instead of Jaragua (*Hyparrhenia rufa*), which is of low nutritive quality. Then, average grazing capacity is expected to increase from 2.3 cows per hectare at present to 5.0 cows per hectare. The grazing capacity will be increased even more, if grass weeds and legumes are introduced in addition to Otoreño I. However introducing legumes may host white flies, which is a vector of virus disease of the vegetables introduced into the Scheme and this eventuality shall be investigated beforehand.

Once it will be established, Otoreño I grassland, (drilling in one meter interrow space, fertilization with 40 kg of N per hectare, 30 kg of P205 and K20 per hectare) will not be renovated during at least 10 years, if the same amount of fertilizers as the initial are applied annually.

(2) Estimation of the grazing capacity

The "Unité Bétail Tropical" (UBT, livestock unit converted into 250 kg of cattle) was adopted to estimate the grazing capacity in the Study Area, considering that cattle is in the Study Area is rather small. The amount of grass grazed by cattle in the natural grass land is at least 6.25 kg per head per day (6.3 kg per head per day after correction of digestive energy). But

is rather small. The amount of grass grazed by cattle in the natural grass land is at least 6.25 kg per head per day (6.3 kg per head per day after correction of digestive energy). But grazing capacity was estimated based on the assumption that grazing capacity in pasture rises by 1.5 times compared with natural grassland, because most of cattle in the Study Area are grazed in the pasture.

Crop residues also can be used as for feeding to compensate feed shortage. Crop residues is characterized by being: a) low in digestibility, b) poor in digestible proteins, c) high in calories. The amount of crop residues in the Study Area is estimated as follows; a) harvest index (weight of harvesting organ / total dry weight) is 0.5 for rice, 0.4 for maize, 0.3 for field beans, b) crop residue = total production / (1 - harvest index). Average utilization rate of crop residues can be maintained at 75 percent, when crop residues are cut up, and increase up to 80 percent, when salt is added. Average utilization rate of crop residues adopted in this Study is 60 percent, as cattle are grazing in the field after harvesting. The grazing capacity is estimated as being the same as grassland.

Estimation of Grazing Capacity in the Study Area

Grazing capacities (head/ha/year)	Cultivated Area (ha)		Number of head of cattle			
	Present	Plan	Present	Plan	Present	Plan
Grass (a)	2.0	2.0	1,790	1,522	3,600	3,000
Grass (b)	3.0	3.0	350	-	1,100	-
Grass (c)	-	5.0	-	322		1,600
Shrub & grass	1.5	1.5	1,310	625	2,000	900
Rice residue	0.79	1.23	2,018	3,024	1,000	2,200
Maize residue	0.55	1.01	922	1,653	300	1,000
Bean residue	0.34	0.55	499	552	100	200
Total	-	-	6,889	7,698	8,100	8,900

Grass (a): by rain-fed. Grass (b): irrigated by existing facilities,
Grass (c): to be irrigated by planned facilities

The grazing capacity in the Study Area is estimated for 8,900 head of cattle in the scheme, instead of 8,100 head of cattle at present. Grazing capacity in the Study Area will increase, although grass land and pasture are converted to cultivated land. Effective grazing and transportation of rain season cropping residues from the cultivated land to grass land and pasture is indispensable, as double cropping will be introduced in the Study Area.

5.2 Farmer Organizations Supporting Plan

5.2.1 Agricultural Development Center

In order to implement the proposed Project successfully, an Agricultural Development Center will be established. The Center will be constructed at the site of the current Agricultural Extension Office. The Center will have the facilities of a central office, a farmers center, a storage, a garage and a drying yard for farm products. In addition, a demonstration farm will be constructed for strengthening of agricultural extension services.

Besides the current staff members (11 members for research, extension services and social promotion works), a head of the center and a group of engineers and technical staff members will be recruited. A group of engineers and technical staff consist of a civil engineer, an agricultual engineer, an agronomist, an institutional expert and 6 assistants. Main task of this technical group are: (i) supervision of construction works; (ii) training on operation and maintenance works; and (iii) formation of farmer organizations. The technical group will supervise the construction works and at the same time they will promote the formation of farmer organizations, i.e. water users associations. This group will give technical advice to the farmer organizations on preparation of farming plan, water distribution plan, collection of water charge, operation and maintenance of irrigation facilities, etc. After conducting 5 years of technical advice and training, all the irrigation facilities will be transferred to the water users associations.

5.2.2 Water Users Associations (WUA)

(1) Organization and Operation of WUA

As recommended in the General Law for Water, a WUA (Water Users Association) will be formed at each irrigation sub-project area. At the first step, the tertiary canal groups will be formed at each tertiary canal area. Then, the secondary canal groups will be formed at the secondary canal area and the main canal group(s) at the main canal area. A WUA will finally be formed at each irrigation sub-project area. All the WUAs at 8 sub-project areas will form a water users association union.

Although the detailed organization of each WUA will be stipulated in the articles of the association, a WUA will generally be headed by a representative who will be assisted by an operation manager, an maintenance manager and an administration staff. The tertiary, secondary and main canal groups will have the similar organization. The union of WUAs will be headed by a chairman who will be assisted by a deputy chairman, a secretary, a treasury and an auditor. The federation will have its general meeting at least once a year. Executive staff of the union will have the term of service of 2 years. Half of the executive staff will be subject to election every 2 years.

Main duties of the union of WUAs are as follows:

a) preparation of farming plan
b) preparation of water distribution plan
c) operation and maintenance works
d) management of collected water fees

Main duties of each WUA are as follows:

a) gate operation
b) daily maintenance of irrigation facilities
c) cleaning of irrigation facilities
d) collection of water fee

(2) Location of WUAs

It is considered appropriate to locate WUAs at the following villages. Selection of the same is based primarily on its better accesibility. Communal centers, to be constructed in the following villages, can be utilized as field offices for WUAs activities.

Irrigation Sub-Project Area	No. of Farms (Estimate)	Location of WUAs
1) Grande de Otoro Left Bank	48	San Pablo
2) Grande de Otoro Right Bank	45	Hda. San Miguel
3) Yucanguare Right Bank	100	La Angostura
4) Yucanguare Left Bank	5	San Lorenzo
5) Naranjo	30	Tatumbla
6) Mixcure	36	El Cipres
7) Cumes	20	Hda. San Miguel
8) Aro	20	El Porvenir
Total:	278	

5.2.3 Strengthening of Agricultural Cooperatives

(1) Reformed Sector

As mentioned in Chapter 3, there are farmer organizations such as Farmer Groups (level-1), Associative Enterprises for agricultural production (level-2) and an Associative Enterprise for agricultural processing and marketing (level-3) in Jesus de Otoro Municipality. With the implementation of the proposed Project, it will be more necessary for farmers to transform their organizations into well managed entity; from level-1 groups to level-2 enterprises, and from level-2 enterprises to level-3 enterprises. Transformation of these organizations shall be conducted in parallel with the formation of WUAs mentioned above.

Land reform beneficiaries groups have been assisted by INA and RRNN to transform from Farmer Groups (level-1) to level-2 Associative Enterprises (AEs). Out of these farmer organizations, six AEs formed a level-3 Associative Enterprise called EACTSO in 1991. Although some Farmer Groups are under process of tranformation from level-1 to level-2, these groups can join the EACTSO in the future.

(2) Technical Assistance for Cooperatives

Establishment of agricultural cooperatives would be highly recommended for private owner farmers based on the regulations stipulated in the Cooperatives Law in Honduras (Decree No. 65-87). Prior to the establishment of the cooperatives, technical advice and training program are available through IHDECOOP.

At least 20 members are reuired to establish a cooperative. At the first step, formation of a temporary Board of Directors is required. For the temporary Board of Directors, training and educational program necessary for the establishment and manegement of a cooperative will be given by CHC (Cooperatives Federation of Honduras) and its subsidiary organization: IFC (Institute for Research and Formation). The program includes training and

education concerning: (i) general information of cooperatives; (ii) preparation of internal regulations; (iii) accounting method; (iv) budget preparation; and (v) management skills for executive members of cooperatives.

(3) Organization and Operation of Cooperatives

There is a cooperative organized by coffee producers in Jesus de Otoro Municipality. However, no cooperative has been organized by producers of basic grains and vegetables. It is highly recommended, therefore, to establish cooperatives in the future when irrigation facilities will be established and agricultural production will be extensively increased. It will not be appropriate to establish each cooperative in each sub-project area because at least 20 members are required for the establishment of a cooperative. At the first step, it is recommended to establish two cooperatives; one at the right bank and another at left bank of the Grande de Otoro river. At the initial stage, main tasks of the cooperatives will primarily be placed on the provision of agricultural credit and supply of agricultural inputs. Tasks of the cooperatives will be expanded to agricultural processing and marketing of farm products at the later stage when the agricultural production will be increased and become stable.

A cooperative can be established by 20 or more members and it is necessary to form a Board of Directors. The Borad of Directors consists of a chairman, a deputy chairman, a secretary, a treasury, and an advisor. In addition, establishment of a Borad of Auditors is required. A manager will be appointed to carry out the daily management works of the cooperative. Training program is available by several institutions as mentioned above to train the executive staffs of the cooperatives. It is also necessary to contact some of the existing cooperatives (e.g. Siguatepeque Horticultural Cooperative) to learn the know-how of operation and management of the cooperative.

5.3 Irrigation and Drainage Plan

5.3.1 Water Requirement for Irrigation

The requirement of water for irrigation is determined by the water consumptive use for each crop, farm losses and conveyance loss, etc. Based on the two cropping patterns proposed in the Project, water requirement for each cropping pattern has been calculated. Calculation of the water requirement has been made for 10-days each, in the order described below.

Considering that such crops as upland rice, maize, frijoles and vegetables have been proposed in the cropping pattern, water requirement for upland crops cultivation has been applied for the calculation.

1. Water Consumptive Use of Crops

* Calculation of potential evapotranspiration (ETo)
* Calculation of the crop coefficients in each growing stage (Kc)
* Calculation of the water consumptive use of crops (FC = ETo * Kc)

2. Net Water Requirement

* Calculation of the effective rainfall (RE)
* Calculation of the total ready available moisture (TRAM)
* Calculation of the Net Water Requirement (FWR = FC - RE)

3. Water Requirement for Irrigation

* Calculation of the irrigation efficiency (Ep)
* Calculation of the irrigation water requirement (GWR = FWR / Ep)

In the study, the crop coefficients recommended by the United Nations Organization for the Food and Agriculture (FAO: Irrigation and Drainage Paper - Crop Water Requirement, Revised 1977)has been uses. For the calculation of the net water requirement, the effective rainfall in one standard year (with probability of non-exceedance of 1/5) has been used and the following criteria have been applied:

Daily rainfall < 5 mm	RE = 0 mm
5 mm < daily rainfall < TRAM	RE = Daily rainfall (mm)
TRAM < Daily rainfall <	RE = 49.4 mm

The water volume deviated in each proposed intake was calculated based on gross water requirement, proposed cropping pattern and the net irrigation area in each sub-project (Table 5.3.1).

5.3.2 *Intake Facilities*

Eight sites have been identified for intake facilities (two each for the Grande de Otoro and Yucanguare rivers and one each for the Naranjo, Mixcure, Cumes and Aro), based on the survey works of cross and vertical sections of the rivers, topographical and geological investigations, (Fig.6.2.1, Annex I).

Based on the geological investigations, the intake facilities of floting type have been designed. For its design, the following values with the flood discharge for 50 years of return probability were used:

Outline of Headworks Design

Irrigation Areas	Intake Elevation (m)	Intake Max. Vol. (m3/s)	Irrigation Area (ha)	Flood Discharge (m3/s)
Grande de Otoro Left bank	592.1	0.72	760	1,309.6
Grande de Otoro Right bank	566.1	0.22	227	1,343.6
Yucanguare Right bank	658.0	0.35	368	609.8
Yucanguare Left bank	634.0	0.17	172	728.6
Naranjo	656.0	0.29	300	137.4
Mixcure	630.0	0.42	430	129.1
Cumes	594.0	0.34	358	117.4
Aro	641.7	0.07	72	135.6

5.3.3 Irrigation Method and Blocks

According to the basic intake rate tests, the stabilized infiltration capacity of the Project Area is lower than 50 mm/hr. From this fgure, furrow or border irrigation is considered to be suitable in this area. Taking into consideration the topographical condition (slightly steep gradient) and the kind of crops selected for the Project, the furrow irrigation method has been applied. The water will be supplied directly from the intakes to irrigate the respective areas during 24 hours a day.

Standard size of terminal irrigation block has been decided to be 2 ha considering the topographical conditions and future mechanization of farming practices. Size of one block will be 200 m by 100 m, as shown in Fig. 5.3.1.

In view of the fact that a part of the terminal irrigation block area have slightly undulating topography where leveling works would be needed. Such leveling works have been considered as a part of land consolidation works.

5.3.4 Irrigation Facilities

For the areas of the eight sub-projects, the respective plan of irrigation and drainage facilities has been elaborated. Each irrigation system consists of intake facility, and main, secondary and tertiary canals.

The main canals will be installed almost along the contour lines

from the proposed intakes for each river, and basically will be of the open type, with concrete lining in order to minimize the water losses that can be produced in the route and reduce the damage of the channel, because the canal length is considerably long in comparison with the irrigation areas.

The profile of the facilities of each sub-project is detailed in Table 5.3.2.

5.3.5 Drainage

(1) Basic Concept

The main drainage channels in the Project Area are the Grande de Otoro River and the six tributaries which flow through the valley. Those basins have relatively deep ravine and steep gradients, having enough drainage capacity.

No elaborate study has been made on the preventive measures against flood of these rivers, considering that up to now there have been no record of serious damage of flood, and few possibility of flood damage in the future is foreseen.

Regarding the drainage in the agriculture lands, ill-drained farm land can be seen in the lower parts of the area due to drainage deficiency. Therefore, formulation of drainage plan is required in due consideration of the proposed new irrigation systems.

(2) Designed Drainage Discharge

Generally a drainage plan involves the evacuation of the rain and excess irrigation water. In this Study, the efforts will be concentrated on the drainage of the excess rain water, as the main irrigation system will be furrow irrigation method. The important rainfall within the Area occur mostly as continuous rain for 2 or 3 days, with the following return probabilities:

Return Probability	Daily Rainfall	Continuous Rainfall	
		2 days	3 days
20	88.0	115.4	130.7
10	77.4	104.1	120.5
5	66.9	92.0	108.9

For the design rainfall for drainage, the values of the return probability of 5 years are taken, in accordance with the irrigation plan, and the design flood is determined from the continuous rainfall for 3 days considering the rainfall pattern of the Area. The drainage discharge of design was calculated by means of the Rational Formula.

Therefore the drainage discharge per unit area will be 6.11

lit/sec/ha in the drainage plan (drainage canals within the farm lots).

5.3.6 Drainage Facilities

The drainage channels are comprised of main and secondary canals and farm ditches in order to evacuate the excess water of the lots. In this case the Grande de Otoro River and its tributaries would play the role of main channel. The secondary drainage canals will be constructed between the secondary irrigation canals with the following length:

Irrigation Sub-Project	Drainage Canal Length
Grande de Otoro, Left bank:	2.1 km
Grande de Otoro, Right bank:	1.2 km
Yucanguare, Right bank:	1.6 km
Yucanguare, Left bank:	0.5 km
Naranjo:	1.1 km
Mixcure:	0.5 km
Cumes:	0.5 km
Aro:	1.1 km

5.3.7 Local Roads

The local roads will serve for the operation and maintenance of the facilities, as well as the transportation of the harvest and the production properties. The roads are projected along the main and secondary channels. The penetration roads network, however, will be laid out dividing the agriculture lands in lots of 20 ha. (Fig. 5.2.2). All the local roads will be filled with rubble, having a width of 4 m.

5.4 Rural Infrastructure Development Plan

5.4.1 Roads and Bridges

(1) Necessity of Improvement of Roads and Bridges

Roads are basic facilities for living and productive activities, the improvement of roads and bridges is indispensable to develop the study area.
The construction and/or rehabilitation of the road network of the Valley, main roads No.22-20, 22-30 and rural roads No.654, 664, 661 and 670, have been carried out, the basic conditions

for development of the project area have been improved. Likewise, a bridge over the Yucanguare River on the rural road No.660 has been built, and 3 more bridges over the Naranjo River, El Agua Blanca Stream and Mixcure River are planned. However, there are rural roads which connect the villages with the main road network, and which remain closed to traffic of vehicles and oxen-hauled carts even during the dry season due to the lack of bridges over rivers and streams, and to the poor evacuation of the rain water.

(2) Basic Policy

The basic policy of the improvement of roads is to avoid unequal benefit distribution of the development of the project area. In order to stabilize the life of the rural population being supplied with services of marketing of products and agricultural inputs, agricultural extension, operation and maintenance of irrigation facilities, etc. the communication with the Jesus de Otoro City which is a center of these services is absolutely necessary.
The roads to be improved were chosen in consideration of the proposed management roads of irrigation canals so that an effective road network should be completed. As the result of the study, the roads to be improved are 3 routes with total length of 5,945m and 3 bridges (Fig 5.4.1).

(3) Road Improvement Plan

The improvement of roads are designed in accordance with gGeneral Specification for the the Construction of Roads, Streets and Bridges" (April, 1987) of SECOPT, and the average width of the roads is 5m.

The following are the roads to be improved (see Annex G Fig.R-1):

a) Route A

Terrero del Guayabal-Road 22-30: 2.16km

The Terrero del Guayabal village has a population of 320 inhabitants. The width of lots of the existing roads is 3 to 4m wide and they have been constructed by the villagers concerned. However, the transit is difficult during dry season, becoming impassable during the rainy season even for oxen-hauled carts because of lack of pavement, side ditches and conduits at a crossing canal. This situation impedes timely transportation of agricultural inputs and

products as well as purchase of daily necessaries.

b) Route B

La Angostura-Road 22-30: 1.2km and a bridge over the Otoro Stream

La Angostura village has a population of 440 inhabitants, most of which are peasants. They use a 2.5km long another earth road connecting with Road 22-30, but it lacks drainage works and it become impassable during the rainy season. For the improvement of this road, much volume of embankment and installation of 4 medium size culverts are necessary, the construction cost will be very expensive. The proposed route was decided after an alternative study with a shorter road (1.2km) connecting also with Road 22-30 and requiring a construction of a submergible type bridge of 12.6m span over the Otoro Stream.

c) Route C

Road 660-El Cipres: 2.6km and a bridge over the Mixcure River

The improvement of this road will benefit El Cipres and Hacienda Guayaman which have a population of 140 inhabitants and an agricultural land area of more than 500ha. Agricultural products and others are presently transported through a pedestrian suspension bridge over the Rio Grande de Otoro, which is in very bad conditions. On the other hand, the improvement of this road will facilitate the construction of the irrigation infrastructures of the Project.

d) Submergible type bridge on Road 670 over Aro River

The Road 670 is presently under construction by SECOPT in the span between San Marcos and San Rafael, however, there is not a plan to construct a bridge over the Aro River. Therefore, 1,650 inhabitants of Hacienda San Rafael, Las Crucitas, El Porvenir and the surrounding villages would be isolated during flood. Therefore the construction of this bridge of 36m is considered necessary, and to be used by approximately 20,000 vehicles per year.

5.4.2 Water Supply Plan

The field work in Phase II made it clear that a water supply plan had ceased to be necessary to stabilize the rural life in the study area due to the following reasons.
The water supply systems commenced in 1993 in San Marcos, Las Tranquitas, Hacienda El Porvenir and La Coyotera with the CRS financing. Also, it was started in Jesus de Otoro City in 1993. In addition, Japan International Cooperation Agency has carried out a basic design study for groundwater development in San Miguel, Santo Domingo, Llano de Maye and La Angostura. From the view point of health, the groundwater supply is more favorable than surface runoff water.
On the other hand, according to the CRS, the existing water supply system at the Santo Domingo- San Pablo is easily possible to supply water to Hacienda Guayaman and El Cipres because the topographical conditions and the water resources allow to supply water to the villages only by extension of conduction lines and construction of a new regulating tank. The CRS has intention to supply technical assistance and the materials if villagers organize themselves and supply labor.

5.4.3 Assembly hall

At present assembly halls were constructed by financial assistance of the Spanish International Cooperation Agency at San Francisco, Hacienda Guayaman, Hacienda El Porvenir, San Marcos and La Gloria.
There is a strong necessity for El Terrero del Guayabal, La Angostura and Santo Domingo, which have a population of 319, 440 and 407 inhabitants respectively, to have assembly halls. They would allow villagers to hold their meetings which are held in the schools. Likewise, the assembly halls will make it possible to organize women's clubs where vocational training may be carried out, to carry out social activities to obtain funds to cover expenses (sugar, fuel, etc.) of the milk program in all schools, as well as to have a suitable place for the children's vaccination programmed by CESAMO.
Otherwise, with the construction of irrigation systems, it is necessary to have an office at the local level for their operation and maintenance. In order to improve farmer's living conditions and to carry out the best operation and maintenance, 6 assembly halls at San Lorenzo, El Cipres, Hacienda El Porvenir, San Miguel and San Pablo will be constructed (Fig 5.4.1). The assembly halls will have an approximate area of 200 m2.

5.4.4 Agricultural Development Center

(1) Basic Policy

In order to strengthen agricultural development in the project

area, an establishment of Agricultural Development Center is proposed where the introduction and extension of water management technology and farming technology will be carried out.

This Center should become a nucleus of administrative and agricultural activities relating to the Project, which promote modernization of the regional agriculture through the extension of modernized technology in soil conservation, crops diversification, post harvest treatment and marketing. In order to improve the agricultural technology, construction of a demonstration farm of 4.4ha is proposed.

(2) Plan Description

The Agricultural Development Center will be constructed in the site of the Jesus de Otoro Agricultural Branch Office of the regional Department of Agriculture in Intibuca Department, which is located at the center of the Otoro Valley where the ample land is available for the Project facilities.

This Center is composed of the following facilities.

- Main Building: approximate area of 250m2
- Farmer's Center: approximate area of 200m2
- Warehouse: approximate area of 150m2
- Garage: approximate area of 84m2
- Drying Area: approximate area of 360m2
- Water Tank: approximate capacity of 2.25m3
- Demonstration Farm: approximate area of 4.4ha

Table 5.1.1
(1/2) THE RELATION BETWEEN SOIL PROPERTIES AND SUITABLE CROPS(CONTINUED)

Zona							
Número de Grupo	4	5	3	2	1	6	7
Características	Estrato de suelo efectiva moderadamente profundidad, textura moderada(Fa,aF) y drenaje bien.	Relieve poco ondulado y textura moderada(FA)	Estrato de suelo efectiva profundidad, textura pesado(Fa-A) y drenaje imperfecto	Estrato de suelo efectiva moderadamente profundidad, textura pesado(F-A) y drenaje imperfecto	Textura pesado de suelo superficial (A-F) y drenaje imperfecto	Estrato de suelo efectiva superficial, textura pesado-(Fa-A), drenaje moderamente bien o muy pobremente, piedras superficiales y rocas en predios	Estrato de suelo efectiva muy superficial, textura mediano(F), drenaje moderamente bien o bien, rocas superficial en exceso y rocas en aéreas no cultivadas
Unizidad en Mapa	La mayor parte de VEC(II)	Una parte de VEG(II)	Una parte de SMI (III) y PIT(III)	LOM(III-IV) SL-PRA(III-IV) AGUB(III) ARRO(III)	MAY(III-IV),COM(-III-IV),PA-GU (III-IV),MOR(IV), POR(IV)	ECI-GUA(IV) OTO(IV)	SF-SD(VIII) Unaparte de SMI(VII)
Producto Agrícola Adecuados							
Citricos	●						
Ajonjoli	●	●					
Girasol	●	●		●		●	
Chile	●	●					
Achiote							
Mango	●	●	●			●	
Papaya		●	●	●		●	
Piña		●	●	●		●	
Higuera							
Aguacate	●	●					
Bonano	●						
Platano							
Palma africana			●			●	
Tabaco					●	●	
Algodón			●			●	
Grama	●	●	●	●	●	●	●

Table 5.1.1
(2/2) THE RELATION BETWEEN SOIL PROPERTIES AND SUITABLE CROPS

Zona							
Número de Grupo	4	5	3	2	1	6	7
Características	Estrato de suelo efectiva moderadamente profundidad, textura moderada(Fa,aF) y drenaje bien.	Relieve poco ondulado y textura moderada(FA)	Estrato de suelo efectiva profundidad, textura pesado(Fa-A) y drenaje imperfecto	Estrato de suelo efectiva moderadamente profundidad, textura pesado(F-A) y drenaje imperfecto	Textura pesado de suelo superficial (A-F) y drenaje imperfecto	Estrato de suelo efectiva superficial, textura pesado-(Fa-A), drenaje moderamente bien o muy pobremente, piedras superficiales y rocas en predios	Estrato de suelo efectiva muy superficial, textura mediano(F), drenaje moderamente bien o bien, rocas superficial en exceso y rocas en aéreas no cultivadas
Unisidad en Mapa	La mayor parte de VEG(II)	Una parte de VEG(II)	Una parte de SMI (III) y PIT(III)	LOM(III-IV) SL-PRA(III-IV) AGUB(III) ARRO(III)	MAY(III-IV),COM(-III-IV),PA-GU (III-IV),MOR(IV), POR(IV)	ECI-GUA(IV) OTO(IV)	SF-SD(VIII) Unaparte de SMI(VII)
Producto Agrícola Adecuados							
Arroz			●	●	●	●	
Maíz		●	●	●	●	●	
Sorgo		●	●	●	●	●	
Caña		●	●	●		●	
Frijoles	●	●					
Soya	●	●					
Marañón		●	●	●	●	●	
Cacahuete							
Papa		●		●			
Camote	●						
Ayote	●	●	●	●	●	●	
Calabaza	●	●	●	●	●		
Pataste						●	
Pepino	●	●					
Sandía	●						
Melón							
Berenjena	●	●					
Tomate	●						
Okra	●						
Nabo	●						
Rábano							
Cebolla	●	●					
Uva			●			●	
Uba blanca	●						

TABLE 5.1.2 LAND-USE PLAN (ha)

	GURANDE DE OTORO RIVER LEFT		GURANDE DE OTORO RIVER RIGHT		YUCANGUARE RIVER RIGHT		YUCANGUARE RIVER LEFT		NARANJO RIVER		MIXCURE RIVER		CUMES RIVER		ARO RIVER		PROPOSED IRRI. AREA		STUDY AREA	
	①	②	①	②	①	②	①	②	①	②	①	②	①	②	①	②	①	②	①	②
ARROZ	141	380	85	113	193	184	108	86	104	150	90	215	98	161	13	36	832	1.325	1.430	1.923
SIN RIEGO	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	287	252
CON RIEGO	141	380	50	113	193	184	108	86	104	150	90	215	98	161	13	36	797	1.325	1.143	1.671
OTROS CULTIVOS	77	304	38	91	15	147	9	69	0	120	33	172	104	125	6	29	282	1.057	920	1.695
SIN RIEGO	0	0	38	0	0	0	7	0	0	0	0	0	0	0	0	0	45	0	593	548
CON RIEGO	77	304	0	91	15	147	2	69	0	120	33	172	104	125	6	29	237	1.057	327	1.147
PASTURA	157	76	103	23	142	37	11	17	119	30	14	43	109	72	57	7	712	305	2.140	1.733
SIN RIEGO	60	0	103	0	122	0	11	0	0	0	0	0	40	0	57	0	393	0	1.790	1.397
CON RIEGO	97	76	0	23	20	37	0	17	119	30	14	43	69	72	0	7	319	305	350	336
FRUTALES	101	101	6	6	4	4	2	2	0	0	0	0	22	22	0	0	135	135	240	240
MATORRAL	277	0	24	12	54	18	49	0	81	0	186	0	50	0	5	5	726	35	1.310	619
FORESTAL	154	8	27	27	43	43	33	29	66	55	211	82	61	46	8	8	603	298	980	675
OTROS	43	81	1	12	9	27	3	12	5	20	4	26	3	21	1	5	69	204	1.120	1.255
TOTAL	950	950	284	284	460	460	215	215	375	375	538	538	447	447	90	90	3.359	3.359	8.140	8.140

①: ACTUAL
②: PROPOSED

TABLE 5.3.1 GROSS IRRIGATION WATER VOLUME

UNIT : m3/sec

MONTH		①	②	③	④	⑤	⑥	⑦	⑧
JAN	1	0.663	0.198	0.321	0.150	0.262	0.375	0.305	0.063
	2	0.667	0.199	0.323	0.151	0.263	0.378	0.305	0.063
	3	0.647	0.193	0.313	0.146	0.255	0.366	0.295	0.061
FEB	1	0.716	0.214	0.347	0.162	0.283	0.405	0.325	0.068
	2	0.583	0.174	0.282	0.132	0.230	0.330	0.263	0.055
	3	0.442	0.132	0.214	0.100	0.175	0.250	0.199	0.042
MAR	1	0.391	0.117	0.189	0.088	0.154	0.221	0.185	0.037
	2	0.245	0.073	0.118	0.055	0.097	0.138	0.133	0.023
	3	0.126	0.038	0.061	0.029	0.050	0.071	0.091	0.012
APR	1	0.074	0.022	0.036	0.017	0.029	0.042	0.069	0.007
	2	0.084	0.025	0.041	0.019	0.033	0.048	0.079	0.008
	3	0.084	0.025	0.041	0.019	0.033	0.048	0.079	0.008
MAY	1	0.068	0.020	0.033	0.015	0.014	0.011	0.053	0.006
	2	0.052	0.015	0.025	0.012	0.011	0.008	0.034	0.005
	3	0.138	0.041	0.067	0.031	0.028	0.022	0.060	0.013
JUN	1	0.076	0.023	0.037	0.017	0.016	0.012	0.028	0.007
	2	0.286	0.085	0.138	0.065	0.059	0.045	0.118	0.027
	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	1	0.123	0.037	0.060	0.028	0.025	0.019	0.045	0.012
	2	0.253	0.076	0.123	0.057	0.052	0.040	0.100	0.024
	3	0.164	0.049	0.079	0.037	0.034	0.026	0.076	0.016
AUG	1	0.260	0.078	0.126	0.059	0.053	0.041	0.098	0.025
	2	0.412	0.123	0.199	0.093	0.085	0.065	0.158	0.039
	3	0.377	0.113	0.183	0.085	0.077	0.060	0.142	0.036
SEP	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	2	0.446	0.133	0.216	0.101	0.092	0.070	0.182	0.042
	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OCT	1	0.010	0.003	0.005	0.002	0.002	0.002	0.007	0.001
	2	0.044	0.013	0.021	0.010	0.009	0.007	0.028	0.004
	3	0.104	0.031	0.050	0.024	0.021	0.016	0.050	0.010
NOV	1	0.346	0.103	0.167	0.078	0.137	0.196	0.185	0.033
	2	0.194	0.058	0.094	0.044	0.077	0.110	0.104	0.018
	3	0.259	0.077	0.125	0.059	0.102	0.147	0.131	0.025
DEC	1	0.534	0.159	0.258	0.121	0.211	0.302	0.256	0.051
	2	0.431	0.129	0.209	0.098	0.170	0.244	0.204	0.041
	3	0.467	0.139	0.226	0.106	0.184	0.264	0.216	0.044

① : GRANDE DE OTORO RIVER (LEFT)
② : GRANDE DE OTORO RIVER (RIGHT)
③ : YUCANGUARE RIVER (RIGHT)
④ : YUCANGUARE RIVER (LEFT)
⑤ : NARANJO RIVER
⑥ : MIXCURE RIVER
⑦ : CUMES RIVER
⑧ : ARO RIVER

TABLE 5.3.2 MAIN FEATURE OF EACH IRRIGATION SYSTEM
(1/3)

GURANDE DE OTORO RIVER IRRIGATION PLAN (LEFT)

a.	Area	950ha (gross)
b.	Diversion Weir	1 nos.
	- Length	87 m
	- Height	4.5 m
	- Design Headwater Level	592.1 m
	- Design Intake Capacity	0.72 m3/sec
c.	Main Canal	11.5 km
d.	Secondary Canal	20.3 km
e.	Terminal Land Reclamation	760 ha
f.	secondary Drainage Canal	2.1 km
g.	O/M Road	10.3 km

GURANDE DE OTORO RIVER IRRIGATION PLAN (RIGHT)

a.	Area	294 ha (gross)
b.	Diversion Weir	1 nos.
	- Length	90 m
	- Height	4.0 m
	- Design Headwater Level	566.1 m
	- Design Intake Capacity	0.22 m3/sec
c.	Main Canal	6.6 km
d.	Secondary Canal	4.9 km
e.	Terminal Land Reclamation	227 ha
f.	secondary Drainage Canal	1.2 km
g.	O/M Road	6.6 km

YUCANGUARE RIVER IRRIGATION PLAN (RIGHT)

a.	Area	460 ha (gross)
b.	Diversion Weir	1 nos.
	- Length	23 m
	- Height	2.2 m
	- Design Headwater Level	658 m
	- Design Intake Capacity	0.35 m
c.	Main Canal	2.2 km
d.	Secondary Canal	16.0 km
e.	Terminal Land Reclamation	368 ha
f.	secondary Drainage Canal	1.6 km
g.	O/M Road	2.2 km

TABLE 5.3.2 MAIN FEATURE OF EACH IRRIGATION SYSTEM
(2/3)

YUCANGUARE RIVER IRRIGATION PLAN (LEFT)

a.	Area	215 ha (gross)
b.	Diversion Weir	1 nos.
	- Length	45 m
	- Height	3.0 m
	- Design Headwater Level	634.0 m
	- Design Intake Capacity	0.17 m3/sec
c.	Main Canal	1.5 km
d.	Secondary Canal	11.8 km
e.	Terminal Land Reclamation	172 ha
f.	secondary Drainage Canal	0.5 km
g.	O/M Road	1.6 km

NARANJO RIVER IRRIGATION PLAN

a.	Area	375 ha (gross) Right Bank: 252 ha Left Bank : 123 ha
b.	Diversion Weir	1 nos.
	- Length	16.5 m
	- Height	2.1 m
	- Design Headwater Level	656.0 m
	- Design Intake Capacity	0.29 m3/sec Right Bank: 0.19m3/sec Left bank : 0.10 m3/sec
c.	Main Canal	1.6 km
d.	Secondary Canal	11.8 km
e.	Terminal Land Reclamation	300 ha
f.	secondary Drainage Canal	1.1 km
g.	O/M Road	1.6 km

MIXCURE RIVER IRRIGATION PLAN

a.	Area	538 ha (gross) Right Bank: 281 ha Left Bank : 257 ha
b.	Diversion Weir	1 nos.
	- Length	13.0 m
	- Height	3.9 m
	- Design Headwater Level	630.0 m
	- Design Intake Capacity	0.42 m3/sec Right Bank: 0.22 m3/sec Left Bank : 0.20 m3/sec
c.	Main Canal	4.1 km
d.	Secondary Canal	11.3 km
e.	Terminal Land Reclamation	431 ha
f.	secondary Drainage Canal	1.7 km
g.	O/M Road	4.2 km

TABLE 5.3.2 MAIN FEATURE OF EACH IRRIGATION SYSTEM
(3/3)

CUMES RIVER IRRIGATION PLAN

a.	Area	447 ha Right Bank: 226 ha Left Bank : 221 ha
b.	Diversion Weir	1 nos.
	- Length	30.0 m
	- Height	3.0 m
	- Design Headwater Level	594.0 m
	- Design Intake Capacity	0.34 m3/sec Right Bank: 0.17m3/sec Left Bank : 0.17 m3/sec
c.	Main Canal	4.4 km
d.	Secondary Canal	4.8 km
e.	Terminal Land Reclamation	358 ha
f.	secondary Drainage Canal	0.5 km
g.	O/M Road	4.2 km

ARO RIVER IRRIGATION PLAN

a.	Area	90 ha (gross)
b.	Diversion Weir	1 nos.
	- Length	13 m
	- Height	1.8 m
	- Design Headwater Level	641.7 m
	- Design Intake Capacity	0.07 m3/sec
c.	Main Canal	1.9 km
d.	Secondary Canal	5.5 km
e.	Terminal Land Reclamation	72 ha
f.	secondary Drainage Canal	1.1 km
g.	O/M Road	2.2 km

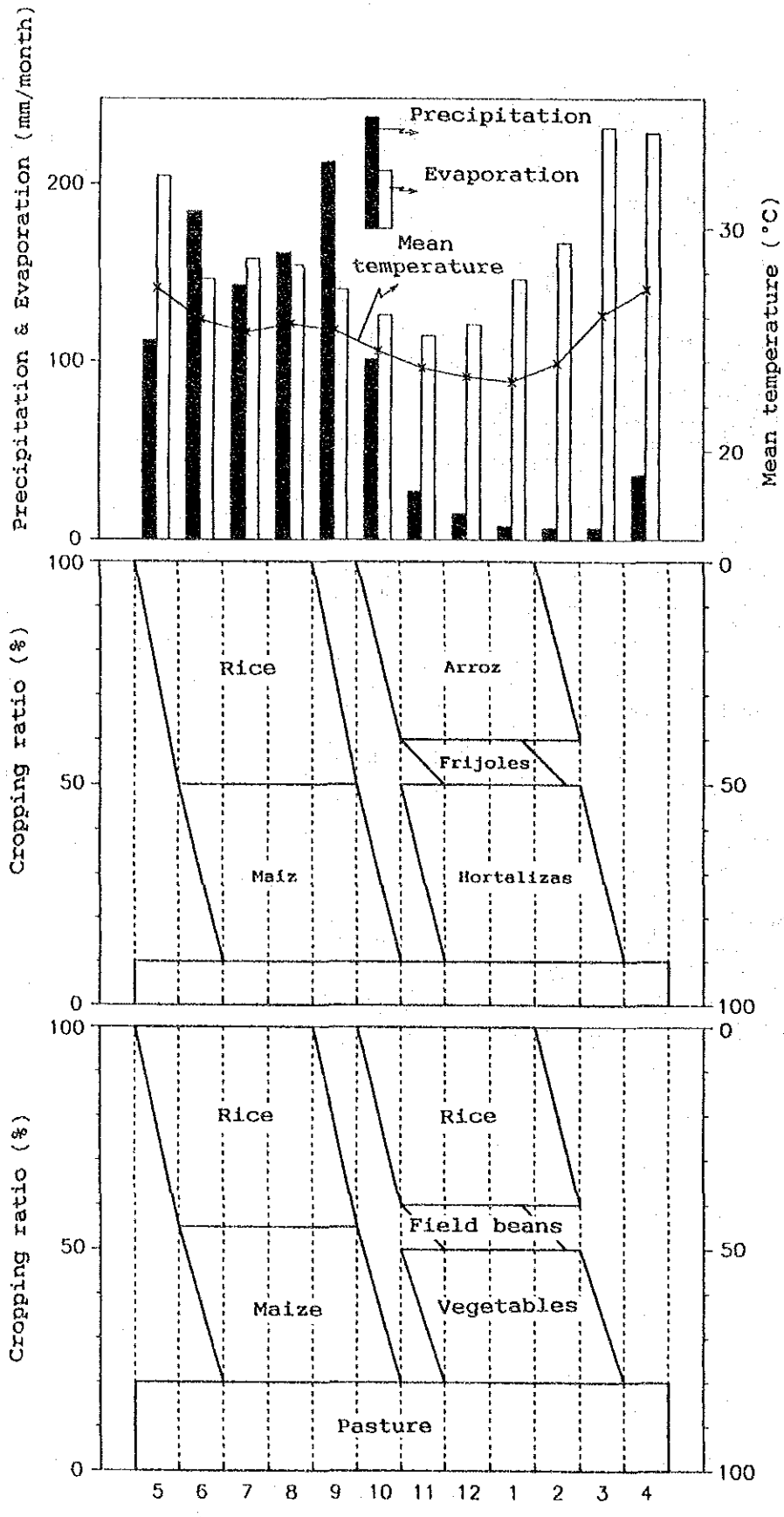


Fig. 5.1.1 Proposed Cropping Pattern

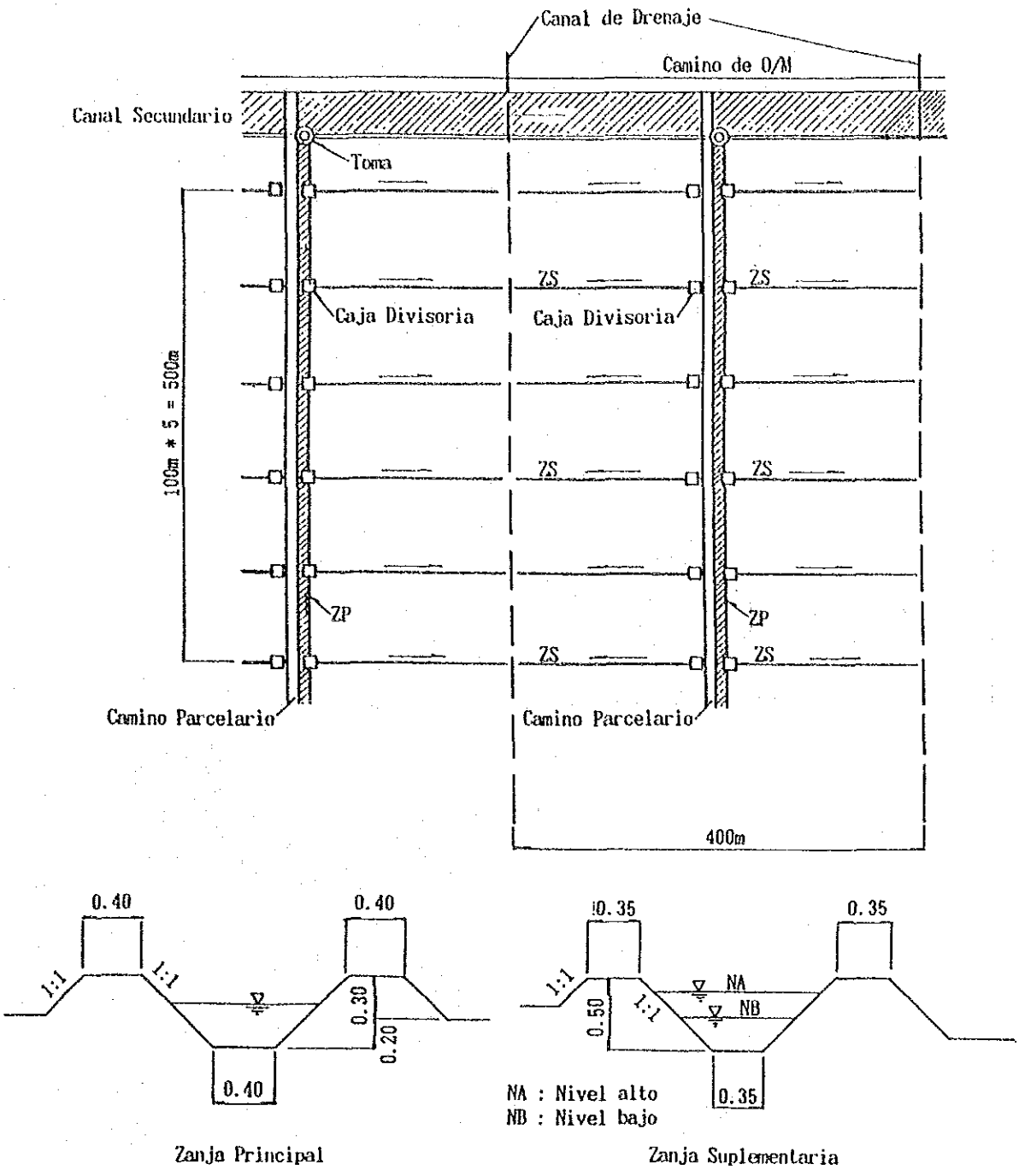


Fig. 5.3.1 TYPICAL LAYOUT OF ON-FARM FACILITIES

PROYECTO DE DESARROLLO AGRICOLA BAJO RIEGO
EN EL VALLE DE OTORO

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON(JICA)

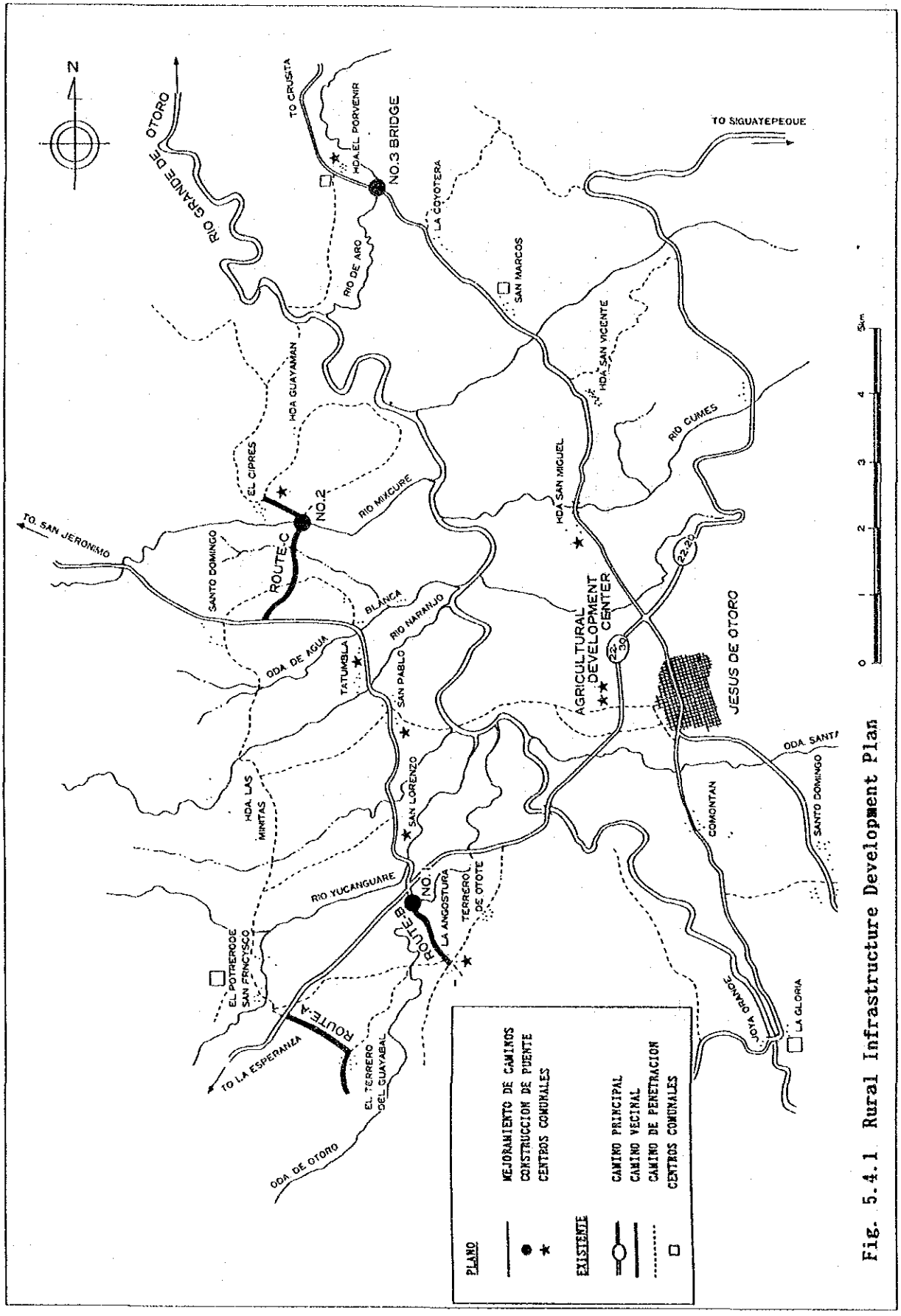


Fig. 5.4.1 Rural Infrastructure Development Plan

CHAPTER VI
IMPLEMENTATION SCHEDULE AND OPERATION & MAINTENANCE

CHAPTER VI
IMPLEMENTATION SCHEDULE AND OPERATION & MAINTENANCE

6.1 Implementation Schedule

6.1.1 Construction Plan

(1) Configuration of the Construction

The proposed facilities will be constructed on the basis of the contracts to be concluded between the executing agency and the local or foreign contractor(s). The contract will include the construction of irrigation and related facilities and procurement of equipment and materials necessary for the execution of the Project.

In addition, some preparatory works which are not included in the said contract would be necessary such as surveying works (to be conducted by the executing agency) and construction of terminal on-farm facilities (to be executed by the farmers under proper guidance of the executing agency).

(2) Outline of the Construction Works

The proposed construction works are classified into two components: (i) construction of irrigation and drainage facilities, and (ii) improvement of rural infrastructures. The first component consists of the independent irrigation system in each sub-project area which will take the water from the intakes installed in the respective water sources. Outline of the facilities are:

1) Irrigation and drainage facilities

a. Intake facilities (head works)
b. Main canals and related structures
c. Secondary canals and related structures
d. Improvement of farm lots
e. Secondary drainage canals and related structures
f. Construction of farm roads

2) Rural infrastructures

a. Agricultural Development Center
b. Improvement of existing roads
c. Community centers

6.1.2 Organization for Project Implementation

(1) Project Administration Office

For the overall Project management, it is proposed to create the Project Administration Office within the DGRH, where all the management regarding the Project can be carried out, including the coordination and negotiation with the related agencies and

institutions. Project Director will be responsible for overall Project management including construction works management during the construction stage, and such operational activities as operation and maintenance of the Project facilities, organization of water user associations, and transfer of operation and management activities to the water user associations after the completion of the Project facilities. The Director should visit the Project Area at least twice a week.

(2) Organization at Construction Stage

In order to facilitate the construction of works, it is proposed to create a Construction Management Office in the Agricultural Development Center, where all the administrative works and coordination with the related agencies and institutions, contractors, water user associations, and individual farmers will be carried out (Fig. 6.1.1). After completion of the construction works, it will become the Project Administration Office to operate and maintain the constructed facilities.

6.1.3 Construction Planning

Construction schedule has been formulated in consideration of meteorological conditions and site situation in order to implement the construction works efficeintly and smoothly (refer to Table 6.1.1).

The proposed Project is composed of eight sub-project irrigation areas, which comprise independent irrigation systems. The implementation plan proposes to execute individually the eight sub-projects in order to yield the benefits as soon as possible.

Within the sub-project areas of the Grande de Otoro, some of existing irrigation areas which presently take water from the tributaries basins are included. In consideration of water right in those irrigation areas, it is required that the priority for implementation should be given to the construction of the Grande Otoro sub-project areas (left bank and right bank sub-project areas) prior to the construction of sub-projects in the tributaries basins.

The priority ranking for implementation of the sub-projects in the tributaries basins has been determined taking into consideration the investment impact (economic effect), size of beneficiary area, easiness of works, etc. The results of the study of priority is presented in Table 6.1.2.

6.2 Operation and Maintenance

6.2.1 Organization for Operation and Maintenance

In accordance with the policy of the Government of Honduras of transferring the management, control, and maintenance activities of the irrigation facilities to the farmers except such large facilities as the dams, the Project has proposed a plan to expedite the transfer of the Project facilities from the executing agency to the farmers as soon as possible, preferably