3.5 Agricultural Economy and Marketing

3.5.1 Agricultural Household Economy

The agricultural household economy was analysed based on the result of the farm management survey of small-scale farmers. Farm management of small-scale farmers is shown in Annex H Table H.6, by farm management types.

Most small-scale farmers cannot cover living expenses with only agricultural incomes and thus have become part-time farm households. The main employers are the nearby banana plantations and other large-scale farms. Although there are differences according to the year and farm management type, income from the non-agriculture amounts to over about 50% of the living expenses.

Annual living expenses of small-scale farmers are estimated to be about 100,000 to 130,000 colones. However, there are existing some of farmers in Maryland of the Zone D, who live with low expenses than that of typical small-scale farmers.

Net agricultural income is estimated at 82,000 to 87,500 colones per year on the mono-culture farm of rice and mix cropped farm of the perennial crops.

3.5.2 Marketing of Agricultural Products

The Area in Matina and Bataan mainly produces bananas, cacao, plantain, rice and tuber crops (including vegetable fruits). The marketing of these agricultural products is as follows:

1) Bananas

Most bananas produced in the Area are exported by private enterprises, which collect, process and pack the fruits. Exported bananas in 1987 reached 3.15 million boxes, an increase

of 8.5 percent as compared with the 1986 level of. 2.9 million boxes or an increase of 248 thousand boxes. The average wholesale price in the New York market has fluctuated since 1980, e.g., US$ 9.58 to US$ 11.63 per box (18.14 kg) in 1985 (Annex H Table H.4.3). The FOB Moin price which corresponds with New York market prices, (see Master Plan Report Annex H Table H.4.1), is growing steadily from US$ 3.40 per box in 1982 to US$ 3.90 in 1987. The quality of the exported bananas is much better than for other countries and high-quality production depends upon technical guidance cultivation and processing by U.S. private enterprises and ASBANA. Banana production is stabilized and is about 1,070 - 1,180 thousand tons for the whole of Costa Rica (Annex H Table H.4.4). The export ratio occupies 85-90% of the total production and domestic consumption amounts to 120-150 thousand tons or 10-15%.

Marketing of bananas is favorable with the United States, West Germany and Italy, and it is expected to increase in the future (see Annex H.4).

2) Rice

The produced rice is sold individually by a rice-mill in the market. Most of rice collected by middlemen is brought to San Jose where domestic markets are located. A part of rice is exported to Panama and Mexico. It is believed that prices are not favourable to the producers where production cost is about 40% higher than the world market price. Improvement in the production costs and productivity are necessary in future to compete in the international market.

3) Cacao

Harvested dried cacao seeds are all taken by chocolate processors in San Jose, and the chocolate products are made and marketed domestically. A little less than 30 percent of the total cacao production is exported. The processor buys directly

at the farm and the farm gate prices range between 90 to 100 colones/kg of 9 to 15% moisture content cacao beans.

An average wholesale prices in New York market brings a high price of US$ 153 per bag (46 kg) in 1977/78, but remain low price of US$ 82 in 1982/83. After 1983/84, the price was recovering, but did not return to the price level before 1978 (Annex H Table H.4.5). Cacao production has deteriorated since 1979 because of Morinia diseases, and/or old-aged. Cacao production decreased from 10,000 tons in 1979 to 2,160 tons in 1983. But it was gradually restored up to 4,450 tons in 1985 (Annex H Table H.4.6, Annex H Fig. H.4.1).

On the other hand, the domestic consumption of cacao in 1986 was equivalent to only 71 percent of that in 1978. Since cacao amounting to 500 to 1,000 tons is imported annually in addition to the domestic production, the domestic consumption seems to be constant. Processing factories (handling 80 - 90% for total production) of two cacao companies in Costa Rica are now operating about 30 - 40% of its capacities and the shortage of raw material (cacao bean) continues for the past 7 years.

The domestic consumption of cacao in the year 2000 is forescasted to be about 6,500 tons, which is by 150 percent larger than that in 1978.

4) Others

Tuber crops, plantains and coconuts are also exported from the Limon port by private enterprises at Matina. Estimated export quantities were about 2,000 tons in 1987. Exports from 1983 to 1987 in the Study Area are shown as follows:

Table 3.5.1 Export Production in the Study Area
(excluded bananas, cacao)

Unit: ton

Crops	1983	1987
Tiquisque	80	520
Chamolan	60	260
Malanga	60	208
Nampi	30	156
Pumpkin	80	364
Plantains	70	335
Fresh coconuts	10	130
Total	400	1,973

(Source) Matina exporter

Another major crop for export is Tiquisque, a tuber crop (Annex H Table H.4.7).

There are no data on the export amount of Tiquisque, however, tuber crops export was 7,800 tons in 1983 and 10,500 tons in 1986, an increase of 1.34 times (Annex H Table H.4.8)

Costa Rica exports tuber crops mainly to the United States. The rough breakdown is 75% for the U.S., followed by United Kingdom, Netherlands and Puerto Rico at about 5 to 6% each. These four countries take 92% of all tuber crops exported from Costa Rica. Miami and New York are the main U.S. consuming cities of tuber crops. The average wholesale price which varies by exporting country in the New York market ranges from U.S$ 1,535 to $ 1,716 per ton (Annex H Table H.4.9). The average export price of taro in the San Jose market was U.S$ 520 per ton in 1986 (Annex H. Table H.4.8).

Costa Rica competes with the Caribbean countries, Central and Southern American countries and the United States in the sale of

agricultural products exporting to the United States. The Moin and Limon ports have modernized container facilities and good ocean lines for Miami and New York as compared with other Central and Southern American countries. Agricultural exports, especially tuber crops, have been increasing steadily over the past four years. Many people from Central and Southern American countries have emigrated to Miami and New York. Their preferences for tuber crops have helped boost demand, consequently causing the exports from Costa Rica to increase. Spanish-Americans account for about 20% of the total population in New York and about 56% in Miami. They have strong preferences for bananas, plantains and tuber crops produced in Central and Southern America, so that even greater demand for plantains and tuber crops can be expected. The population ratio of Spanish-Americans in the United States is as follows:

Table 3.5.2 Spanish Origin American Population in 1980

Unit: 1,000 people

Area	Total Population	Spanish Origin	Spanish Origin Ratio (%)
Around New York	17,539	2,052	11.3
New York City	7,072	1,407	19.9
Around Miami	1,626	580	35.7
Miami City	347	194	55.9
Total - Around the city	19,165	2,632	13.7
- In the city	7,419	1,601	21.6

(Source) U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1987.

Maize, kidney beans and sorghum are sources of food in Costa Rica. The government's purchasing prices are fixed and controlled by the Consejo Nacional de Produccion (CNP) under the consultative council.

The government's purchasing prices are shown as follows:

Table 3.5.3 Government's Purchasing Price

Controlled Crops	Govt. Purchase Price (¢/kg)	Wholesale Price (¢/kg)	Retail Price (¢/kg)	Consumer Price (¢/kg)
Kidney beans	35.79	35.88	37.63	42.10
Maize	13.67	13.94	14.63	16.40
Rice/*	14.20	26.57	27.64	30.40

Note: Above figures are as of September 1987.
/* ... No government purchasing since 1986.
Prices are quoted by the public.
Source: CNP

3.5.3 Farm Credit

More than 80% of the small-scale farmers have not drawn credit properly. The reason is that about 40% of the farming fund of low interest (BID-678, annual interest rate; 15%) for the small -scale farmers has not been collected owing to unprofitable from agricultural production, caused by the plant deseases for cacao and plantain.

Furthermore, it is difficult to make a profit from agricultural production with the existing poor farm conditions such as poor drainage system in parts of the low-lying area and the interest rate of agricultural credit is high. (BID-497, annual interest rate; 20 to 29%)

In the Study Area, there are considerable number of farmer having no land tenure and they cannot to be obtained such financing on the security of a land.

The main sources of institutional credit in the Study Area are the Banco Nacional de Costa Rica (BNCR), which lends directly to farmers with

the guarantee of the saving and credit cooperatives; whereas, crediting is a guarantee with Instituto de Desarrollo Agrario (IDA) and/or on the real rights as security of the own farm land. The Banco de Costa Rica (BCR), Banco de Credito Agricola de Cartago (BAC), Banco Popular y de Dessarrollo Comunal (BPDC) also lend directly to rural producers, but their branch offices, except BNCR, are not located in the Study Area.

On the other hand, since 1985, IDA has provided short term loan (within 15 months), medium term (within 5 years) and long term (within 9 years) at various rates of interest (17 - 22%) for each crop and for each scale of crop, under the financing project of IDA/AID -515-T-034.

3.6 Social Infrastructure and Social Service

3.6.1 Roads

The roads in the Study Area can be divided broadly into three classes, that is, national roads, cantonal roads, and others.

The national roads, following the general law on public roads, are classified into Class I, Class II and Class III roads by MOPT. The National Route 32 is of the Class I type, running along the south border of the area from Limon to San Jose, and passing through Siquirres. This route is a two-lane asphalt road. The section between Siquirres and San Jose was opened in May 1987.

There are no roads of the Class II type in the area. In the Class III type are five routes, 803, 804, 805, 806 and 808. The existing routes mainly connect the principal towns, communities and large-scale banana plantations. These routes are paved by gravel.

The cantonal roads are supplementary roads to the national roads and are unpaved and narrow. In addition, there are roads constructed by IDA for its settlement, private roads for the banana plantation companies and farm roads.

The roads connecting the national road and banana plantation companies are 7 - 8 m wide and are given proper maintenance. There are even roads with simple asphalt pavement (National Route 32 to Bataan section); however, the rest are narrow, 4 m wide, with poor maintenance and their passage are blocked during the rainy season. Especially those roads running along the contour lines form small dikes and become a cause of poor drainage in the farmlands.

As mentioned above, the roads in the area are not maintained satisfactorily due to poor drainage, which is an obstacle to the farmers' life and transportation of farming materials, equipment and agricultural products.

There is no bridge crossing the three large rivers in the Area; Rio Matina, Rio Pacuare and Rio Reventazon, except for National Route 32. This lack of bridges is an obstacle in the development over a wide area.

The roads in each zone are classified as in Table 3.6.1 and Fig. 3.6.1 and the density of roads is highest in the zone B at 4.9 km/1,000 ha, lowest in the zone C at 2.8 km/1,000 ha, and averages 4.1 km/1,000 ha.

3.6.2 Education

There are 41 primary (6 year-compulsory) and secondary schools in the Study Area, apparently satisfying the needs numberwise; however, qualitywise, there are problems such as lack of materials and teachers. The attendance is high: 90% in primary schools and 75% in secondary schools.

There are normal high schools in Limon, Bataan and Siquirres and an agricultural high school in Siquirres. There is a subsidiary (Faculty of Agriculture) of the University of Costa Rica and a private university in Siquirres (Fig 3.6.2).

3.6.3 Public Medical Facilities

The Cantons of Matina and Siquirres included in the Study Area has a central clinic and six substations belonging to the Ministry of Health, and has a traveling clinic and eight infant education and nutrition guidance clinics in Bataan.

There are two free clinics in Siquirres and Matina which belong to the Social Insurance Foundation. There is only one hospital in the province's capital, Limon. Due to lack of medical facilities and personnel, there is no effective management.

3.6.4 Waterworks

In Limon, Siquirres and Bataan, water is supplied from the common wells. Groundwater is supplied as it is without pasteurizing from water towers. Banana plantation companies install deep wells 30 - 60 m in depth, for washing bananas and for living water.

In other communities, each family has a shallow well (3 - 10 m) sometimes containing coliform group. The households and communities on the canals which run parallel with the coast and on the rivers which flow into the canals, use the water of the rivers as living water (25%). For drinking, boiling is required.

Sewerage is rare and waste water discharged as it is without any treatment.

3.6.5 Electric and Communication Facility

(1) Electricity

In this area, electric power supply is in progress and about 80% of all households. Those who have not been supplied electric power are newly-settled farmers, but power distribution works are continually in progress.

(2) Communication

In the urban areas, there is an automatic central telephone switchboard and the service can be said to be relatively good. In the rural areas, the number of telephones drops remarkably.

The radio stations, supplementarily installed in Parismina and Carmen, inform the inhabitants of administrative matters and communal ceremonies.

In the five-year plan, the extension of the telephone network is scheduled and the feeder lines are to be extended from the following urban areas:

Matina	--	Barra de Matina Norte
Matina	--	Barra de Matina Sur
Bataan	--	Santa Marta
Bataan	--	Sara
Siquirres	--	San Alberto Nuevo

3.6.6 Public Transportation

The State Railway connecting Limon and San Jose runs parallel to the National Route 32 in the southern part of the Study Area. The passenger trains do two trips, and the freight train, one trip per day; they are not so important as a means of transport. Nowadays, transport by large trailer trucks plays an important roles.

Other means of transport in the Study Area include the bus connecting Limon, Siquirres, Bataan and Matina. There is a private bus company's traffic network with two to three buses operating per day.

3.7 Settlement and Agricultural Land Development

3.7.1 Condition of Settlement

(1) General

The Settlement Program, eagerly started in 1963 by IDA, aims at alleviating the population concentration in the San Jose sector of the Central Basin, promoting effective land use, and improving the unemployment problem.

According to the settlement results of data executed by IDA, as shown in Table 3.7.1, the highest number of recorded settlements have been in Limon Province, including the study area.

Table 3.7.1 Settlement Results Executed by IDA

Country	Population			Settlement Plan		
	Urban Area	Rural Area	Total	Area (ha)	No. of Families	Year Started
San Jose	635,191	255,243	890,434	4,512	338	1969
Alajuela	107,192	320,770	427,962	55,191	3,770	1964
Cartago	88,486	183,185	271,671	8,065	1,210	1963
Heredia	809,381	116,637	197,575	20,429	1,536	1965
Guanacaste	51,986	143,222	195,208	37,570	1,647	1963
Puntarenas	60,664	205,219	265,883	29,136	1,946	1964
Limon	50,797	117,279	168,076	40,050	3,902	1965
TOTAL	1,075,254	1,341,555	2,416,809	194,953	14,349	-

Note: Population is based on the 1987 census.
Settlement data is from IDA.

(2) Settlement

1) Characteristics of settlement in the Study Area

The settlement program in the Study Area being executed by IDA differs from ordinary projects, i.e., the project does not include a program for the reclamation of unexploited land. IDA makes land readjustments to absentee landowners' land and to national land being illegally cultivated, and then the readjusted land is sold by IDA.

2) Settlement situation

IDA's settlement in the Study Area started in 1965. 1,922 families settled in a 20,769 ha by August 1987. The main features and location of the settlement are shown in Table 3.7.2 and Fig. 3.7.1 respectively.

With the view of establishing small- and medium- scale farmers, IDA sold 10 ha of land, on the average, to each family. IDA had planned colony type villages for the settlers, but the plan did not suit to the nature and habits of the farmers. Each family settled on their own farmland close to a road.

3) Settlement method

To implement a settlement project, the IDA purchases land. The purchase price in 1981 was 4,494 colones/ha. In the Maryland area, which became a settlement area in the comparatively near past, it was 4,291 colones/ha in 1983 and 7,887 colones/ha in 1986. IDA readjusted the purchased land and sold it to applicants at the prices ranging from 10,000 to 16,000 colones/ha (twenty years ago the selling price was 6,000 colones/ha).

Based on IDA's standards (see Annex I), IDA screened applicants and selected settlers. In recent years, the number of applicants (not only from the nearby areas, but also from the entire country) was several times more than planned on.

The selling price of readjusted land to a settler was the total of the land purchase cost, settlement project costs, and loan cost (five years grace period, 20 year repayment period, with annual interest of 7%). Settlers can obtain loans from the IDA or the National Bank for the purpose of purchasing land. Housing loans and agriculture operating loans can be obtained from the Agricultural Financial Corporation (CAJA AGRARIA).

IDA constructs 6.0 m wide gravel roads on 14.0 m wide roadways in settlement areas and each plot of land faces the road. Drainage ditches are installed along both sides of the roadway. The slopes of the ditches correspond to the road's longitudinal slope; therefore, the roads at concave points tend to flood.

If a settlement area is large, IDA reserves certain plots for public use or commercial zones. Land having unsuitable topographic or soil condition is omitted from the project area and reserved by IDA for future development.

4) Housing of settlers

The average family in a settlement area has five members. At the beginning stage of settlement, the settlers build shacks with their own money, but recently they are building 36 m^2 houses by using money obtained through loans. The construction cost is 40,327 to 65,000 colones.

Groundwater for daily use is pumped up by hand. Electricity is supplied shortly after starting a settlement.

5) Problems confronting settlements

The problems on settlements executed by IDA are as follows;

A) The access roads to settlement areas are very scarce.

B) The agricultural supporting services by the government for new settlers are much needed to adapt them to the new environment, such as climate, soil, crops, diseases, market etc.

C) Since the average farmland size is 10 ha, the size is insufficient for livestock from the profitability.

(3) Present types of farming communities

The types of farming communities are classified as follows;

"A" Type: Suburban type, such as on the outskirts of Limon, Siquirres, Bataan, etc.
"B" Type: Colony type, such as in banana plantations and the surrounding areas.
"C" Type: Scattered type, common in settlement areas.

However, in a new settlement area, such as Negev where the area for public and commercial facilities is reserved previously at the rate of 10 ha in 1,000 ha of the settlement area, the colony type prevails in the surrounding of the facility area and the scattered type in the other area. In such areas, the reasons for adopting the scattered type are as follows:

1) The settlers ought to live on their own land or in the vicinity.

2) The low-ranked plots in land classification are sold in larger sizes, 15 to 17 ha, and are used mainly for livestock; thus, the scattered type is needed for breeding.

3.7.2 Farmland Consolidation Situation

(1) General

Farmland consolidation in the Study Area which began with banana plantations has been developed.

Since these plantations have their own drainage facilities and consolidated land, consolidation causes drainage problems and disrupts the general farmland in the surrounding areas.

The farm lands other than the banana plantations, where there is less flood damage, are used as upland grass fields and for rice cropping. The low-lying areas around small rivers in the Study Area are mainly covered with wet-land trees, Cacao is cultivated in places with favorably topographical conditions.

Except for the rice cropping areas, farmland consolidation has not been implemented. (See Annex G.1)

(2) Condition of Facilities in Existing Farmland

Existing farmland is used for perennial crops, such as bananas, cacao, coconut palms, and plantain; and annual crops, such as rice, maize, tuber crops, and kidney beans.

Though banana plantation fields have such basic necessary facilities as drainage canals, farm roads, and transportation equipment, most cacao fields do not have sufficient facilities, and the fields of annual crops, except for some rice fields, have insufficient drainage facilities.

The present condition of roads and drainage canals in the existing farms is as follows;

1) Farm Roads

Farm roads in the Study Area are almost nonexistent. It is inconvenient to transport agricultural equipments materials and harvested crops to and from farms that do not face main roads.

2) Drainage Canals

The drainage canal conditions of the banana plantations and farmlands are as follows.

(a) Drainage system in banana plantations

Banana plantations have well arranged drainage systems; The principal drainage canals are installed at 1,000 m intervals, secondary canals are installed at 100 m intervals and ditch canals are installed at 20 to 40 m intervals, depending on the ground condition.

The drainage systems are classified into three groups based on the ditch canal interval (20 m, 30 m, or 40 m). The drainage canals' densities for the three classes are calculated as shown in Table 3.7.3.

Table 3.7.3 Drainage System in Banana Plantations

Class	Canal Length per 10 ha (km)				Drainage Canal Density
	Principal Canal	Secondary Canal	Ditch Canal	Total	(Km/1000 ha)
1	0.1	1.0	4.9	6.0	600
2	0.1	1.0	3.2	4.3	430
3	0.1	1.0	2.4	3.5	350

A typical arrangement for a drainage system in a banana plantation is shown in Fig. 3.7.2.

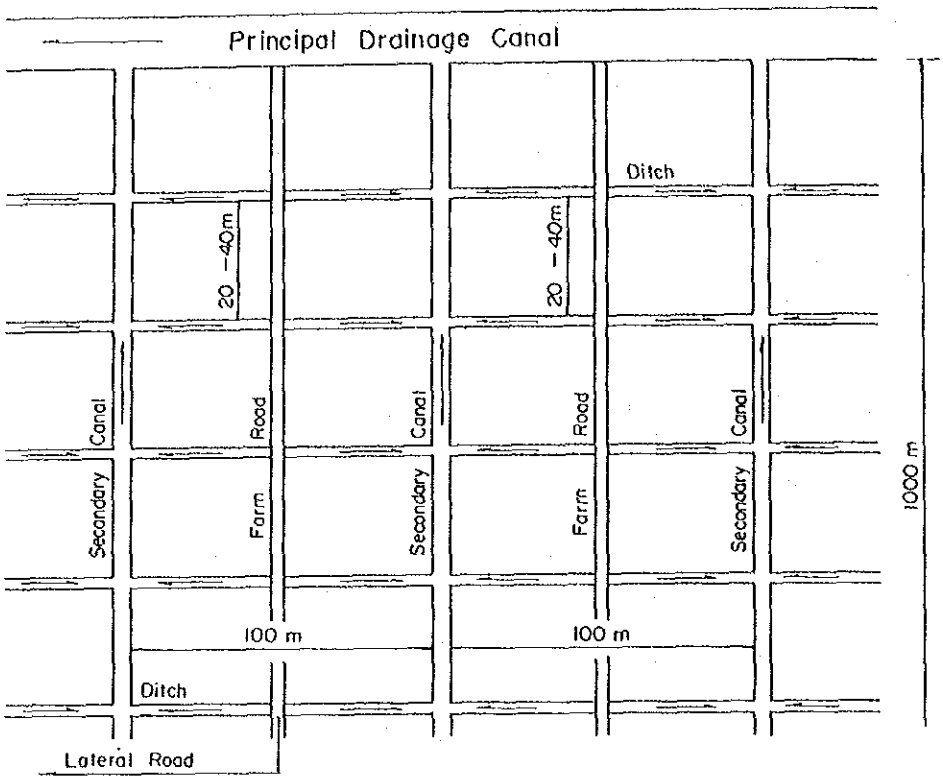


Fig. 3.7.2 Existing Drainage Network in Banana Plantation

The dimensions of drainage canals are illustrated in Fig. 3.7.3.

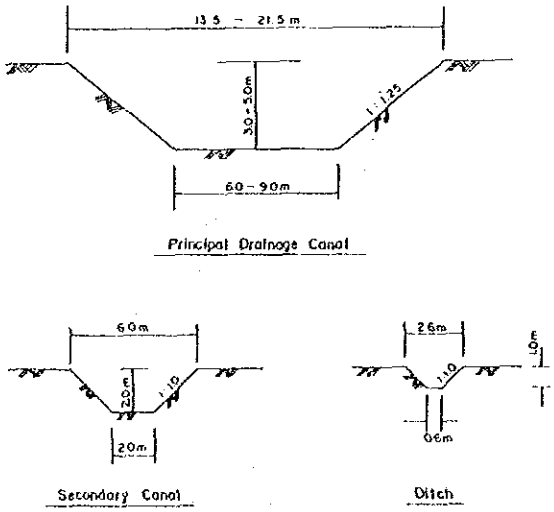


Fig 3.7.3 Present Cross section of drainage Canal in Banana Plantation

b) Drainage System in Farmlands

Only a few farmlands have their own ditch canals, and even the ditch canals are not connected to the principal and secondary drainage canals, so that there is no effective drainage from the farmlands.

Since small and medium sized rivers and existing drainage canals, receive large quantity of surface water from upstream banana plantations, the downstream area has an issue on the disposal of drain.

Agricultural activities are performed under such drainage conditions. Some farmers have devised drainage countermeasures as described below;

- Crops are planted on the banks of ditches dug to a depth of 0.2 to 0.3 m at intervals of 0.3 to 0.6 m.

- Ditches are redug to a depth of 0.6 to 1.0 m at intervals of 20 to 50 m, and the soil from the ditches is then levelled out. Crops are planted in this soil.

However, such countermeasures are performed in only a few areas.

3.7.3 Irrigation

(1) Irrigation

Presently, irrigation is not being used for the following reasons:

- The annual rainfall[1/] ranges from 3,000 to 5,000 mm and the average is about 3,500 mm.
- Rainfall throughout the year is plentiful, and even in the relatively dry period from February to April, the monthly mean rainfalls[1/] reaches about 200 mm.

(Note) 1/ Data source: Monthly rainfall at La Lola for the period from 1970 to 1985.

(2) Rainfall (Effective Rainfall) and Water Requirements of Main Crops 1/

A comparison of the rainfall in the Study Area and the water requirement of the main crops, (see Annex F.1) reveals the following points.

- Water requirements for main crops have not exceeded the mean effective rainfall over a period of 36 years (1950 - 1985), in LA Lola Expermental Station.

- In the case that the effective rainfall 2/ is only 70% of the mean effective rainfall in drought conditions, only the water requirements for cacao are short by 1 to 19% in the three months from February to April.

Moreover, when the following existing cultivation conditions for cacao are considered, there appears to be little necessity for irrigation.

- Cacao on the La Lola Experimental Station of CATIE is growing prolifically on an inclined field with a low groundwater table. 3/

- Since cacao has a long root zone of about 1.0 to 1.5 m, it can be expected to obtain a relatively large amount of water from the soil, in addition to the effective rainfall.

(Note)

1/ : Rice, maize, kidney beans, tuber crops, bananas and cacao.

2/ : Irrigation criteria of Costa Rica.

3/ : According to explanation by the staff, the ordinary ground -water table is estimated to be at a depth of 8.0 meters.

3.8 Drainage

3.8.1 Present Drainage System

Most of the drainage in the Study Area depends on the natural rivers, and some artificial drainage canals constructed by banana plantation also flow into the rivers eventually.

All of the rivers flow into the Navigable Canal paralleling the coast, and there are no rivers that flow directly into the Caribbean Sea. The Navigable Canal extends 105 km from Limon to the Nicaragua border. There are a few river-mouths along the Canal; three river-mouth inside the Study Area and one 10 km southeast from the Area boundary. The drainage systems in the Study Area and the drainage area in each system are shown in Fig. 3.8.1 and Table 3.8.1 respectively.

The main drainage basin boundaries in the Study Area are the Rio Matina, Rio Pacuare, and Rio Reventazon, excepting the hilly areas in the southwestern part of the Area.

The main drainage facilities in the Study Area are summarized as follows:

Large rivers

Among the rivers in the Study Area, Rio Chirripo, Rio Barbilla, Rio Matina (downstream of the confluence of Rio Chirripo and Rio Barbilla, about 1 km south of the urban area of Matina), Rio Pacuare, Rio Reventazon and Rio Parismina (downstream of Rio Reventazon) have a large mountainous watershed outside the Study Area which differs from other small rivers inside the Area inside the Area. The total length of the rivers in the Area is 124 km and the total drainage area bordering the Navigable Canal is 5,016 km^2, (refer to 2.1., Annex F)

The rivers in the Study Area are approximately 3 m - 4 m deep and approximately 60 m - 90 m wide and form a rectangular shape. Both banks of these rivers form natural embankments of sedimentary earth and sand.

Small rivers inside the Study Area

Most of the drainage areas of small rivers are in the Study Area. Small rivers inside the Area. This drainage area is extremely small in comparison with the abovementioned large rivers' basin. (refer to Table 3.8.1., for drainage area)

The river cross sections have a base width of 6 m - 10 m, a crest width of 10 m - 15 m and a depth of 2 m - 5 m. The total length of the small rivers is 234 km. (see Annex F Table F.2.2) These rivers play an important role as main drainage canals for the farmland inside the Study Area.

There are few small rivers inside the Area which join large rivers except in the hilly areas through Monte Verde to Siquirres, and most rivers flow into the Navigable Canal.

Canal

There exist drainage canals constructed by existing or withdrawn banana plantation. These canals have a depth of 3 m - 4 m and a bottom width of 5 m - 15 m in and near the plantations, but the canal sections become small at some distance downstream from the plantations, and the depths and base widths are 2 m - 3 m respectively.

Most canals constructed in the abandoned banana plantations are positioned as main drainage canals in the IDA settlements, but these canals are not being operated or maintained at present.

All existing canals flow into small rivers inside the Study Area, not into large rivers. The total length of these canals is 128 km. (refer to 2.3., Annex F)

Navigable Canal

The Navigable Canal is situated at the lowest part of the Study Area along the Caribbean coast. The small rivers inside the Area discharge to rivers mentioned into the Caribbean Sea, by way of the Navigable Canal.

The Canal not only functions as the main drainage course but is also being used for tourism and transport of wood, agricultural products produced in the vicinity of the canal and daily necessities of the rural inhabitants who live around the canal. The Canal in the Study Area between Rio Parismina and Rio Toro is 37 km and 200 m to 250 m long. The width of the Canal is mostly 20 m to 40 m in the section from Rio Madre de Dios to Rio Pacuare and from Rio Chiquero to Rio Parismina, the width is 200 m - 250 m and the depth is 2 m - 5 m. (refer to Table F.2.4., Annex F)

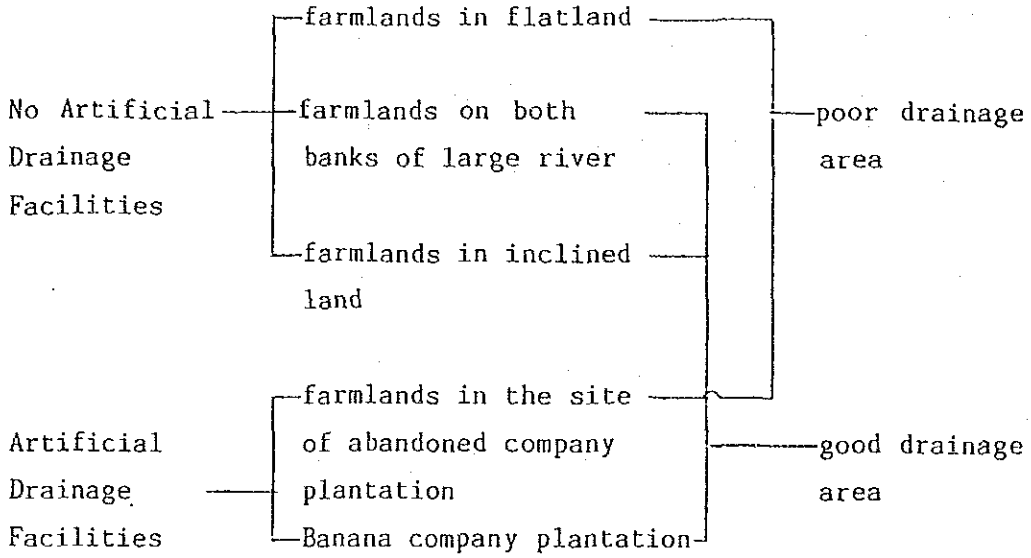
River-mouth

There are three river mouths in the Study Area -- Rio Pacuare, Rio Matina and Rio Parismina. The widths are: Rio Matina, about 50 m; Rio Pacuare, about 60 m; and Rio Parismina, about 80 m. The depth is 4.5 m - 5.5 m in the deepest place.

A value of EC = 0.08 - 0.17 micro mho/cm was measured at points 1.0 m and 3.0 m deep. It is confirmed that the Caribbean Sea does not flow back into the Study Area. (see Annex F Table F.2.5)

3.8.2 Drainage Situation in Farmlands

The Study Area except for banana company plantations with completed drainage facilities, hilly areas in the southwestern part at an elevation of 20 m - 60 m, and farmland on both banks of large rivers such as Rio Reventazon, etc., is often flooded by rainfall. It is a poor drainage area and the ordinary groundwater table rises to the surface during the rainy season. The drainage of the area can be classified as follows, according to the existence of artificial drainage facilities and the topographical features.



(1) Drainage conditions

1) Poor drainage area

a) Farmland in the flatland

Because of lack of drainage canals in the farmland, the rainfall passes downstream through canals and small rivers in the Study Area after stagnating on the ground surface. Also, due to insufficient drainage capacity from the small rivers and canals, the farmlands are inundated every year.

The inundations get worse on the downstream side, which can be classified as follows.

- Under 10 m elevation

  The area at less than an elevation of 10 m is inundated three to four times a year, with a depth of flooding 0.3 m - 0.7 m. The inundation continues three to four days.

- Elevation between 10 m and 20 m

  The area with an elevation between 10 m and 20 m is flooded two to three times a year, with depth of 0.3 m - 0.5 m. The inundation continue two to three days. However, the depth of flood waters in and around Bataan is under 0.3 m, because the drainage area of upstream is small, even if surface flooding continues for long duration.

b) Farmlands of abandoned plantation

Abandoned canals play a role of drainage canal. However, the draiange capacity is too small due to no maintainance, then drainage conditions are also poor, similar to the area mintioned-above in a).

2) Good drainage area

a) Farmland on both banks of large river

Since the farmland is located in the most upstream of its drainage area and has a favorable permeability of the soil, the area is not inundated even during rainfall. However, there are some places inundated by the flood of river.

b) Farmland on inclined land

The area with an elevation of 20 m - 60 m and gradient of 1/50 - 1/100 located in the southwestern part of the Study Area is not inundated during rainfall.

c) Banana company plantations

Banana company plantations amounting to 7,640 ha are scattered in the Area. Since these plantations have been provided with main drainage canals and terminal drainage canals, they are not inundated by rainfall.

(2) Groundwater table conditions

The groundwater table of the wells used for domestic purposes by farmers in the area has been observed. Since the wells exist in and around the farmlands and are located at almost same elevation of the farmland, the groundwater table of these wells is considered as that of the farmlands.

1) Poor drainage area

a) Farmland in the flatland

The grouwndwater table deffers between the rainy and dry seasons (February to April) and is affected by rainfall. The poor drainage is considered to result from the rainfall stagnatingon the ground sruface for long periods because of the lack of proper canal networks. The groundwater table during the rainy season usually rises nearly to the ground surface. It seems that this elevation is not lower than 0.3 m below the ground surface.

b) Farmlands on abandoned plantation sites

The grounwater table elevation is similar to the Area in a).

2) Good draiange area

a) Farmlands on both banks of large rivers

The groundwater table is 1.0 m below the ground surface during the rainy season and 3.0 m lower than the surface in the dry season. The groundwater table is more affected by river water level than by rainfall.

b) Farmland in inclined land

The groundwater table is 1.0 m lower than the ground surface during the rainy season, and 3.0 m lower in the dry season. This groundwater table is low in comparison with farmland on flat land.

c) Banana company plantations

Observation of the dry and wet conditions of drainage canals (depth: 1.0 m) in the banana plantations indicated that the bottom of the canals was only slightly wet during periods of no rainfall in both the rainy and dry seasons.

It, therfore, seems that the groundwater table is 1.0 to 1.5 m lower than the ground surface all year round.

3.8.3 Poor Drainage Area

(1) Classification of drainage conditions

Investigations were made into drainage conditions in the area. These drainage conditions are classified into I - VII according to the existence of artificial drainage facilities, topography, annual number of floods, depth of flood water, number of days of flooding, and groundwater table during the rainy season, as shown in Table 3.8.2. (see Annex F. 3.3)

In the 64,500 ha [1]/ of the Study Area, the extent of the drainage conditions calssified in I -VII (Fig.3.8.2), and Table 3.8.3 lists the area according to drainage conditions of each zone.

[1]/ An area for rivers, urban area and railway of 2,500 ha is excluded from total area of 6,700 ha.

(2) Extent of poor drainage and damage conditions

The classifications I - IV and V - VII correspond to the poor drainage areas and good drainage areas respectively. As a result, the area of poor drainage in the Study Area was estimated to be about 39,920 ha except for permanent swamps of 5,870 ha corresponding to I. The poor drainage is hampering factors on agricultural production. The yield production of crops produced in the study area except for bananas is lower than the national level and the Atlantic Region.

If drainage is improved in the poor drainage areas, an annual increase in production of approximately 9,200 tons, valued at approximately US$3,400,000 can be expected. (Table 3.8.4. and Annex F Table F. 3.3)

Table 3.8.2 Present Drainage Situation

Existence of Facilities	Major Division	Minor Division	Inundation in normal year: Times	Days	Depth	Groundwater table during the rain season	Classification	Drainage Condition
No Drainage Facilities	Permanent swamp					GL±0.0m	I	
	Farmland	Farmland under 10m	3~4	2~3	0.5~0.7m	GL±0.0~-0.5m	II	Poor drainage area
		" between 10~20m	2~3	2	0.3~0.5m	GL±0.0~-0.5m	III	
		" over 10 m	2~3	less 2	under0.3m	GL±0.0~-0.5m	IV	
	Farmland in the both banks of large rivers		2~5	1~2	0.4~0.5m	under GL -0.5m	V	Good drainage area
	Farmland inclined land					under GL -1.5m	VI	
Existing Drainage Facilities	Site of abandoned plantation	Luzon				under GL -1.5m	VII	
		Other	(Classified into I ~ III accrding to the places)				I ~ III	Poor drainage area
	Banana plantation					under GL -1.5m	VII	Good drainage area

Table 3.8.3 Area According to Drainage Condition

unit : ha

Division / Zone	Permanent Swamp I	Poor Drainage Area II	III	IV	sub-total	Good Drainage Area V	VI	VII	sub-total	Total
A	1,370	5,300	2,250	380	7,930	0	0	1,100	1,100	10,400
B	1,650	7,620	2,400	3,170	13,190	580	1,710	1,670	4,160	19,000
C	0	2,960	3,830	0	6,790	630	2,670	1,810	5,110	11,900
D	2,850	7,150	4,860	0	12,010	1,050	4,430	2,860	8,340	23,200
Total	5,870	23,030	13,340	3,550	39,920	2,260	8,810	7,640	18,710	64,500

I : Permanent swamp
II : Poor drainage area under 10 m (elevation)
III : Poor drainage area between 10~20m(elevation)
IV : Poor drainage area over 10m(elevation)
V : Good drainage area in the both banks of large rivers
VI : Good drainage area in inclined land between 20~60 m(elevation)
VII : Banana Plantation

Table 3.8.4 Annual Increased Production and Increased Amount by Drainage Improvement

Zone	Planted area within poor drainage area (ha)	Increased production (t)	Inctreased amount (US$1,000)
A	4,516.0	1,903.6	793
B	7,108.0	3,791.9	1,234
C	3,296.0	1,364.7	484
D	7,843.0	2,148.5	887
Total	23,063.0	9,208.7	3,398

3.8.4 Cause of poor drainage

The study area has heavy annual average rainfall of 3,500 mm. Heavy rains of between 100 to 150 mm/day occur 2.6 times and those over 150 mm/day, 1.3 times during the year on an average.

Under these condition, though gravity drainage is possible in farmlands excluding permanent swamps, in flat farmlands except for banana plantations the prompt removal of surface water is very difficult. The reason for the difficulty is the lack of drainage capacity of small rivers and canals which act as the main drainage canal and of a proper canal network due to an insufficiency of terminal drainage canals. In the rainy season, the groundwater table is high and the farm lands are often flooded.

Based on the measurement of the cross sections, the discharge capacities of rivers and canals in poor drainage areas were estimated. The drainage capacities of the banana plantations and neighborhood, and the rivers under railroad bridges have sufficient capacity, however, small rivers and canals in poor drainage areas have markedly lack capacity. (For actual flow capacity of canals and small rivers inside the area, see Annex F Table F. 3. 1)

3.9 Flood

3.9.1 Flood occurrence

In January, April and December of 1970, the rivers of Rio Matina, Rio Chirripo, Rio Barbilla, Rio Pacuare and Rio Reventazon overflowed and the whole of the Study Area suffered flood damage. This flood corresponds to one with an occurrence probability of once in 35 years. (based on the hydrographic records of Rio Pacuare). There have been no much large floods since 1970, but there have been small ones. The flood situation is described below.

- Rio Chirripo

In 1982, the Rio Chirripo overflowed at the downstream near National Route 32, and the water reached the village of Estrada. This flooding had an occurrence probability of once in five years.

- Rio Barbilla

In 1980, this river overflowed at the north of Davao and the water reached almost as far as the entrance of Bataan. The flood had an occurrence probability of once in five years.

- Rio Matina

This river has overflowed every year in the middle-and downstream areas. The flooding depth is commonly 40 to 50 cm and the flood lasts for one or two days.

The floods affected Hilda on the left bank and flowed in the direction of the banana plantations, overflowing the roads on the right bank.

- Rio Pacuare

Since 1970, there have been no floods in Indiana Dos and Indiana Tres. However, this river overflows often in its middle-and downstream areas. From hydrographic records and the river capacity, it is estimated that generally, floods have occurred once every two years. (Overflow lasts for two or three days)

In the area between Cultivez and Perla on the right bank of the middle-stream section, the flood water flows in the direction of the eastern canal overflowing the roads to a depth of 50 cm. In downstream, the river mainly overflows the left bank, with a depth of 30 cm - 40 cm.

- Rio Reventazon

There have been no floods upstream since 1970. However, the river overflows several times a year in its middle-and downstream sections. The flooding depth of 40cm - 50 cm is common, but sometimes it reaches 1 m. The overflow usually lasts two to three days. The influence of the flood extends to the western part 1 km away from Maryland, also to the down stream of the Rio Aguas Zarcas.

3.9.2 Causes of flood

The existing flood protection facilities for each river in the Study Area are as follows;

- In the upperstream of the Rio Reventazon, there are three dikes (total length 1,650 m) constructed by MOPT in 1979 to protect the roads.

- The banana plantations along the rivers have dikes (2 to 3 m in height) on the riverside.

There are no other flood protection facilities except those mentioned above. The rivers do not have sufficient drainage capacity in the middle-and downstream sections where the gradient is gentle. As a result, the floods occur.

A comparison of the drainage capacity of the rivers and the flood discharge, measuring the typical cross sections at the overflow points in the rivers shows that the drainage capacities in the middle- and downstream sections of each river, excluding the Rio Chirripo and Rio Barbilla, are 60 to 80 % of the flood discharge with a probability of once in two years in average daily discharge. (see Annex F Table F. 4. 1)

CHAPTER 4 DEVELOPMENT PLAN

Chapter 4 Development Plan

4.1 Basic Concept

4.1.1 Necessity for Development

As explained in the actual situation of the Study Area, this area favored with good natural conditions such as climate, topography and soil, and has abundant land resource. Nevertheless, it is not in a position to make effective use of these resources. That is, of the 67,000 ha in the Study Area, the area available for agriculture is about 44,000 ha, however, at present the cultivated area is only about 20,000 ha, of which 7,640 ha is being used for banana plantations. In addition to the low-rated land use, agricultural productivity is also low, as mentioned above.

The causes which impede agricultural production in this area are summarized as follows:

"Hardware" causes

1) Because of the insufficient drainage facilities, drainage is poor and accordingly inundation occurs and the groundwater table is risen, which is an obstacle to cultivation.

2) Because of the small drainage capacity of the rivers, the flooding occurs repeatedly over a very large area, by which the drainage condition get worse, in addition to direct damage to crops.

3) Owing to the shortage of roads, areas which have some distance from the roads are in a difficult position to effective development. Further, it takes time and money to transport agricultural products, materials and equipment.

"Software" causes

1) Small and medium scale farmers are not able to easily obtain farm credit because of low agricultural productivity. Furthermore, due to a 24% interest on the farm credit, the rate of interest is a burden on farm household economy.

2) The marketing system is not sufficient for agricultural products. Intermediaries negotiate with farmers to buy products at a low price, which adversely affects the farm household economy.

3) Neither farmers' organizations nor the agricultural supporting system are well-organized, and it is clear that the farmers who do not receive technical assisstance have low productivity. So the expansion of these organizations is required.

Among the drawbacks to agricultural development, poor drainage and flood are the biggest ones. Under the circumstances, for the purpose of establishment of medium- and small-scale farmers in this Area, promotion of regional and national economy and improvement of farmers welfare, it is necessary to promote integrated agricultural development laying stress on drainage improvement and flood protection.

4.1.2 Possibilities for Development

In 67,000 ha of the Study Area, there exist banana company plantations with an area of 7,640 ha operated mainly by foreign enterprise. They have overcome bad conditions such as poor drainage, flood damage and defective agricultural infrastructure by independently constructing drains, dikes and farm roads on surrounding farmland. At present, they obtain high yields of 45.0 tons/ha on an average in banana cultivation. Most of the banana plantations occupy rather topographically good land along the large rivers. However, some lands which have unfavorable condition in topography are used for banana plantation. This means that the climate and soil in this Area has the high potential for an increase in agricultural productivity.

Rice (upland field rice) cropping is prevailing over this Area, but the rice is cultivated in fields which do not have as good drainage conditions as the banana plantations. Despite being inundated several times, an average crop yield is 3.0 tons/ha. Accordingly, the exclusion of causes which impede agricultural development in this Area will make the Area to be vital of these lands.

4.1.3 Basic Policy for Development

(1) Development Plan

Grasping the actual situation and causes impeding agricultural development, the development plans of several aspects are proposed as follows:

(1) Drainage Improvement Plan
(2) Flood Protection Plan
(3) Agricultural Production Plan
(4) Road Network Plan
(5) Land Consolidation Plan
(6) Settlement and Rural Development Plan
(7) Agricultural Promotion Plan

(2) Project Area

In the Study Area there are virgin forests for about 9,000 ha in the low-lying area along the Navigable Canal and banana plantations for about 7,500 ha. There are low-lying areas where gravity drainage is impossible. Whether these area are included in the development area or not is considered as follows:

Virgin forest

The virgin forests which extend with the width of about 2 - 5 km along the Canal are omitted from the development area in this master plan for the following reasons; such as living area for rare animals, important resources for cutting forests by the authorities

concerned from the view point of environmental conservation. Further the gravity drainage in this area is impossible because of flat and low-lying area.

Banana Plantation

The banana plantations in the Study Area are owned by enterprises or cooperatives, and are not privately owned. All plantations are fully equipped with lateral drains as well as principal. The particular techniques are applied, and market and distribution channels also function well. Accordingly, these banana plantations are not considered in the master plan and excluded from the actual development area.

Low elevation area

In some areas of low elevation, gravity drainage is impossible by affection of the Caribbean sea water level as well as the water levels of the Navigable Canal, rivers and drainage canals,and they are not suitable for cultivation due to high groundwater table.

The limit to which gravity drainage is possible is the contour line of 2.0 m above sea level according to the results of hydraulic study, taking into consideration of the distance from rivers and drainage canals (see Annex F.5.6).

In the area of 2.0 m above sea level, the constant groundwater table is supposed to be -0.5 m from ground surface, so that planting is possible with the exception of perennial crops which are rooted deeply.

Consequently, the areas lower than 2.0 m above sea level are out of the development area. This low lands are inundated at flood time during heavy rain in present, serving as a retarding basin.

Others

There are scattered some forests except for the low-lying area. Whether forests must be conserved or developed, and the possibility of land reclamation was studied. The experimental farms to the research institution were excluded.

As a result of the study, agricultural land to be developed in this master plan is as follows:

Table 4.1.1 Agricultural Land to be Developed

Unit : ha

Description		Total 67,000	Zone A 10,800	Zone B 19,500	Zone C 12,600	Zone D 24,100
Outside of Develop-ment Area	Virgin forests	9,150	2,150	3,220	740	3,040
	Banana plantations	7,640	1,100	1,870	1,810	2,860
	Other forests	2,270	130	750	1,390	-
	Urban road	2,500	400	500	700	900
	River land					
	Others	1,200	-	580	400	220
	Total	22,760	3,780	6,920	5,040	7,020
Agricultural land to be developed		44,240	7,020	12,580	7,650	17,080

(3) Zoning for Development Planning

At the moment of the implementation of the agricultural integrated development in this Area, it seems that it is difficult to formulate the devolopment plan as one project for the whole area of 67,000 ha. Therefore, the whole Project Area will be divided into four zones by rivers and drainage systems, and then each plan mentioned above (such as drainage improvement plan, flood protection plan, agricultural production plan, flood protection plan, road network plan, land consolidation plan, settlement and rural delvelopment plan and agricultural promotion plan) for these zones will be examined. Through the enhancement of developing effects in each zone by implemtntation of a multi-development project, the Project aims at the development of the whole Project Area.

Table 4.1.2 Zoning for Development Planning

Zone	Drainage System	Administrative Classification		Area
		Canton	District	
A	Rio Toro - Rio Matina	Matina	Carandi	10,800ha
B	Rio Matina - Rio Madre de Dios	Matina	Matina Bataan	19,500ha
C	Rio Madre de Dios - Rio Pacuare	Siqui-rres	Pacuarito	12,600ha
D	Rio Pacuare - Rio Reventazon	Siqui-rres	Siqui-rres	24,100ha
Total				67,000ha

(4) Characteristics of Each Zone

Zone A:

This zone is, in general, low-lying, at maximum 20 m, 50% of which is flat and low land less than 6 m above sea level. The area which requires drainage improvement reaches 74%.

The ratio of settlement and small-scale farmers are high following

Zone B. As the railway traverses in the middle of the Zone, the development of the road network has been delayed. Canals are few in the lowlands, so many poor drainage areas exist, where much rice and pasture are grown. In some area in this Zone, large-scale rice cultivation with single cropping is also performed. It is located at near to Limon city, so that the socio-economic conditions is under the influence of Limon.

Zone B:

This Zone is higher than Zone A in elevation. Approximately 40% is less than 6 m above sea level. For this reason, 58% is classified as poor drainage areas such as lowlands and hollows in the middle. Land holding indicates that settlements occupy 9,930 ha (about 52%) and are most stable. Though many drainage canals of banana plantations and small rivers exist, the poor drainage area is vastly extended. As Rio Madre de Dios which is on the boundary of Zone C is narrow in river section and has flooded repeatedly, so countermeasure for flood is required.

Compared with other zones, the ratio of land utilization is low. The causes are defective drainage facilities and high groundwater table. In this zone, the farm products of single cropping is somewhat higher in percentage than that from perennial crops. Urban areas are formed with railway stations at Bataan and Matina as their centers. Near the railways, the banana plantations have been developed for a long time and occupy an important position in relation to the society, economy, marketing and education. As national land is only 6.0%, future settlement has not been planned. The ratio of small farmers is highest among the four zones and farming scale per household is small. Since many farm households exist in this zone, a project effect can be easily attained by improvement of drain and road networks, and is urgently required.

Zone C:

This zone is narrow and long, and its topography is similar to Zone B. The occupancy (14%) of the banana plantationsis high. Drainage canals and road networks have a close relationship to Zone B, but the development has delayed. As the ratio of settlement is lowest, it is necessary to promote the transfer of land ownership. Farms belonging to an experimental and institutional organizations and foliage plant gardens are located in this area and the ratio of land use is also low following Zone B. However, there is a high percentage of perennial crops and the farming scale is largest.

An improvement of Rio Madre de Dios and of the road network will greatly contribute to the effect of development.

Zone D:

This zone is largest and long from south to north and highest in elevation. Approximately 29.0% is less than 6 m above sea level and 53.0% at 6 - 20 m above sea level. The drainage condition is relatively good. But since both sides of this zone are surrounded by the large rivers, it is liable to be damaged by floods. The rate of settlement is somewhat low but its area amounts to 4,000 ha following Zone B. The national land covers 8,430 ha (about 35%) and the future settlement is planned. Siquirres, municipal town of the Canton is an important place in this Zone as society, economy, education, marketing and transportation, and about 40% (7,150) of the population of this zone lives in Siquirres. As the IDA's settlement called Maryland as well as the land to be developed hereafter are located in the interior, the distance to the railway and the National Route 32 is long and this zone is somewhat inferior in the traffic condition. The area which is higher than 10 m above sea level has good soil, and is occupied by banana plantations (2,860 ha).

The rate of land utilization is relatively good but drainage canals and small rivers in the lowland are few. Roads are not sufficient except those of newly constructed ones in the banana plantations and

settlements. Under the circumstances, the infrastructure development is necessary and its effect is considered to be great.

4.2 Drainage Improvement Plan

4.2.1 Basic Policy

(1) Drainage improvement area

Based on result of the field survey and collected data, this Area is divided into 7 classes (I - VII) of drainage conditions (see Table 3.8.3).

The planned area for drainage improvement is 35,200 ha which is deducted an excluded area from the area of classes II - IV classified as poor drainage area. And the area for drainage improvement is divided into 4 zones: Zone A; 7,020 ha, Zone B; 11,480 ha, Zone C; 5,100 ha and Zone D; 11,600 ha(see Table 4.2.1).

However, on planning the drainage canals, the whole drainage canals, the whole drainage area of each canal is counted.

(2) Object of drainage improvement

The objectives of drainage improvement are prompt disposal of the surface water on farmland and lowering of the groundwater table for better condition to grow crops. (At least, 50 cm below from the ground surface)

(3) Drainage improvement method

Taking into consideration the construction costs and operation and maintenance, the pump drainage method is not introduced, and a gravity drainage system will be adopted in this plan.

This drainage system is composed of principal, secondary, tertiary and lateral drainage canals.

The lateral drainage canal receives the water from farmland, and the secondary and tertiary drainage canals collect the water from the

lateral drainage canals and conduct it to the principal drainage canal.

The principal drainage canal carries the water from these canals to the final outlet (rivers, Navigable Canal, etc.).

In planning these drainage canals, a policy which makes use of existing drainage canals and small rivers will be adopted.

4.2.2 Criteria of Drainage Plan

(1) Design rainfall for drainage

Since the rainfall of La Lola Experimental Station of CATIE is judged a representative rainfall for the Area, the rainfall record at this station will be used.

Rainfall with a probability of once in five years will be adopted, as the design rainfall for drainage.

The design rainfall for drainage and rainfall intensity formula are as follows:

- Design rainfall for drainage $R = 196$ (mm/day)

- Rainfall intensity formula $I = \frac{229.0}{t + 4.0}$ (mm/hr)

R: Daily rainfall with a probability of once in five years (mm/day)
I: Average rainfall intensity during continuous rainfall(mm/hr)
t: Duration of rainfall (hr)

(2) Design drainage discharge

The design drainage discharge is calculated by a rational formula. The specific yield discharge per 1 km^2 classified by flood concentration time is as follows:

I Q = 3,575 m^3/sec/Km^2 (t = 4 hr)
II Q = 2,050 m^3/sec/Km^2 (t = 10 hr)
III Q = 1,188 m^3/sec/Km^2 (t = 20 hr)

4.2.3 Layout of Drainage Canals

The lateral drainage canals will be laid out at average intervals of 1,000 m, and the interval will vary according to the topographical conditions, the shape of the farmlands, and the layout of farm roads. The length of canal per a line will range from 1.0 km to 1.5 km.

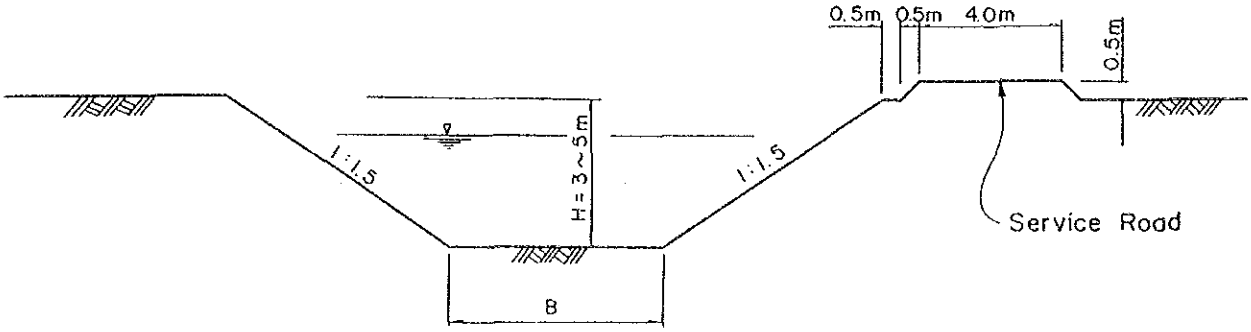
Principal drainage canals will be laid out at intervals of 3 to 4 km, forming a right angle to the coast. The location and length of the proposed principal drainage canals are shown in Table 4.2.2 and Fig. 4.2.1.

The length of principal canals for the proposed drainage system is approximately 190 km including new construction - about 124 km, rehabilitation - about 4 km, and existing canals - about 22 km.

The proposed length of secondary drainage canals is approximately 219 km, which includes canals and rivers available by partial rehabilitation (enlargement of canal cross section, excavation of canal).

4.2.4 Scale and Structure of Drainage Canals

Principal drainage canals will be earth canals in consideration of their objectives and economy. Considering the slope stability and the maintenance, the typical cross section of canals will be as follows:



Note: In case B = 10 m; the service road will be constructed at both sides of the drainage canal.

Fig. 4.2.2 Proposed Cross Section of Principal Drainage Canal

Secondary drainage canals will be unlined in the same reason as the principal drainage canal, and in view of the soil and existing canal conditions, the slope gradient will be set at 1:1.0. The depth of the canal will be set at 2.0m to match the depth (2.0m) of tertiary drainage canals constructed in the farmland of perennial crops. The typical cross section is as follows:

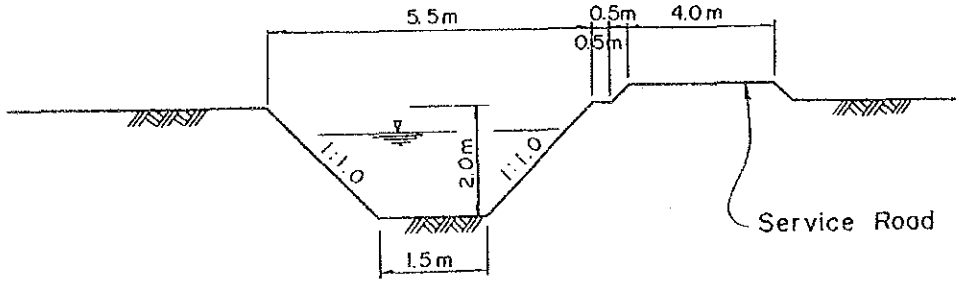


Fig. 4.2.3 Structure of Secondary Drainage Canal

The dimensions of proposed principal and secondary drainage canals are shown in Table 4.2.2.

4.3 Flood Protection Plan

4.3.1 Scope of Flood Protection

The farmlands are inundated by the overflow at the middle- and down stream of Rio Matina, Rio Chirripo, Rio Barbilla, Rio Pacuare and Rio Reventazon. Therefore, the facilities for flood protection will be constructed in the middle- and downstream sections of the rivers.

The sections for the construction of such facilities were selected by field survey, taking proposed land use in consideration. The length of required facilities for the flood protection is 118 km. (see Table 4.3.1).

With the result of inundation analysis in the low-lying area along the Navigable Canal, the rise of flood water level would be extremely small after completion of the Project(see Annex B.3). So that, the measures against high water will not be taken, considering the land use and vegetation in the inundation area.

4.3.2 Flood Protection Method

At sites where the actual river section is insufficient for the design discharge, a low dike will be constructed along both banks of the rivers to protect against floods.

The reason for the adoption of this dike is as follows:

- The actual river cross section to the design discharge is very small, so that the construction costs for the widening of sections by river excavation are very large.

- The land acquisition charge is low.

- Most of the proposed drainage canals will not drain into rivers, so there are few problems from raising the river water level in flood time.

- This protection method has already been used in the Study Area.

4.3.3 Flood Protection Facilities Plan

(1) Design Discharge

As the design discharge for the rivers to be improved, probable floods of once in five years will be adopted in comparative examination with the benefit-cost ratio (B/C) of the amount of annual reduced damage by the construction of flood protection facilities (B) and the annual depreciation cost[2/] of flood protection facilities corresponding to flood probabilities[1/] of once in two years to 20 years (C). (see Annex F.6)

The design discharge of the rivers is as follows:

Rio Chirripo	Q = 1,870 m^3/sec	(D.A. = 1,106 km^2)
Rio Barbilla	Q = 714 m^3/sec	(D.A. = 2.59 km^2)
Rio Matina	Q = 2,151 m^3/sec	(D.A. = 2,151 km^2)
Rio Pacuare	Q = 1,577 m^3/sec	(D.A. = 1,577 km^2)
Rio Reventazon	Q = 2,585 m^3/sec	(D.A. = 2,585 km^2)

1/ Four probability cases : 1/2, 1/5, 1/10 and 1/20

2/ Cost estimation conditions: Interest rate 12% annually, 25 years of durable life for the facilities.

(2) Structure of Dike

The dikes will be constructed by applying the earth from protected areas. The typical cross section of the dike will be in the following (Fig. 4.3.1), considering the scale, the quality of embankment

materials (sandy clay) and its future maintenance. The required dike height (H) and major bed width (B) of the rivers based on the result of hydraulic calculations is H = 2.5- 4.5 m and B = 45- 150 m (see Table 4.3.1)

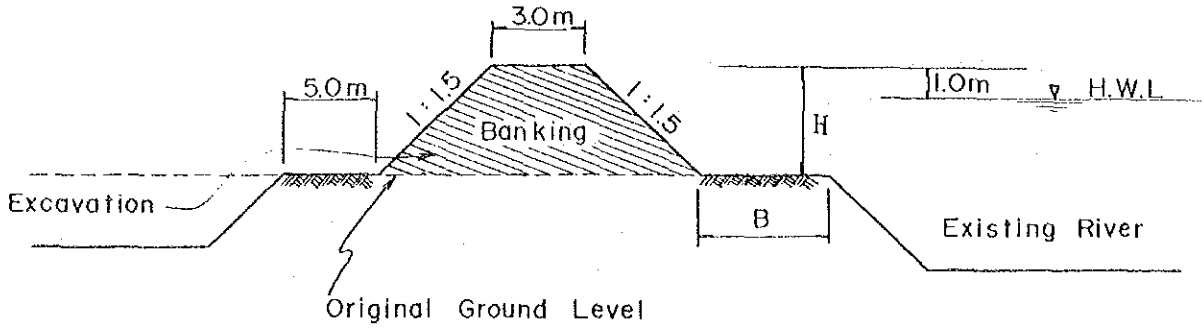


Fig. 4.3.1 Proposed Cross Section of Dike

4.4 Agricultural Production Plan

4.4.1 Land Use Plan

The low rate of planting which results from the present poor drainage of farmland will be bettered by drainage improvement. The rate of land use will remarkably increase because of new settlements. However, in this Area, there are some areas where development should be avoided because of the impossiblility of gravity drainage and the existence of virgin forest. The area which can be made arable has been selected from soil classification and present land use. The area, as a result, amounts to 44,240 ha, excepting banana plantations (see Table 4.1.1). After the projects is completed based on a master plan such as drainage improvement and flood protection, the farming conditions in each Zone will change for the better. However, drainage conditions cannot be exactly the same over the whole area. It would take much time to drain the low-lying area close to the Navigable Canal. Consequently, in this area, plants suitable for growing in a relatively high groundwater level area must be selected. The planned land use map is shown in Fig.4.4.1.

4.4.2 Agricultural Production Plan

(1) Basic Policy

The agricultural production plan is established to increase total agricultural production and income for the small-scale farmers. Accordingly, the plan will be realized by increasing the cropping area, multiplying the cropping pattern and selecting highly profitable crops.

Selection of crops and production plan are considered to conform to the National Agricultural Development Plan in the following aspects:

(1) Physical conditions (elevation and soil)
(2) Farming technical level
(3) Agricultural supporting and extension services
(4) Sales and supply conditions of materials for agricultural production
(5) Marketing (transportation, processing, etc.)
(6) Supply and demand of agricultural products in the target year

(2) Selection of Crops

The following crops are proposed.

Perennial Crops	:	cacao, bananas, coconuts, plantains, and black pepper
Annual Crops	:	rice, maize, kidney beans, and tuber crops
Livestock	:	cattle breeding

The followings are the basic reasons underlining the selection of introduced crops.

1) Bananas

Bananas are ranked second to coffee as an export agricultural product. The production has a great influence on the national economy, because bananas account for approximately 25% of the total export value.

At present, the Government is promoting a plan to increase the production of bananas (Plan de Fomento Bananero) in the Atlantic Region, including the Study Area. The plan is aimed at increasing the production of bananas by 25% up to 1990. Banana production in the Study Area is equivalent to approximately 22% of the total national production and average yield exceeds the national average, and bananas adapt well to this Region.

2) Cacao

Cacao is a profitable crop in the Study Area, and the production in the Area is equivalent to approximately 30% of the national cacao production. The government is promoting a plan to increase the production of cacao (Programa de Fomento Cacaotero)in the Atlantic Region, because the present national cacao production has decreased to one third of its peak.

According to the plan for production of cacao, the possible cacao production area is estimated at 27,000 ha in the Study Area. (see Annex E Table E.2.4)

Total cacao demand of the country has increased approximately 2.3% compared with 1985, and the volume of imported cacao amounted to approximately 760 tons. On the other hand, with the favorable change of the international market price, exportation of cacao was recorded approximately 1,500 tons in 1986, an increase of 15% over 1985.

La Lola Cacao Experimental Station of CATIE, which is the most important cacao research center in Costa Rica, is located in the Study Area and offers technical support services to the farmers. The production of cacao seed in the Study Area is expected, because export of the cacao hybrid seed to neighboring countries is tending to increase in recent years.

3) Coconuts

94% of the total production of coconuts is produced in the Atlantic Region. According to the "Proyecto de Desarrollo Agricola en la Zona Atlantica", the newly coconut production plan of about 5,000 ha is formulated.

ASBANA has reported that the favorable change of international market price and the improvement of productivity by the appearance of high yield varieties made possible to

establish the plan for the expansion of the planting area. Coconuts can be processed into many products such as vegetable oil, detergent and cosmetics. Furthermore, the exportation of coconut seed of the high yield variety "Hibrido Alto del Pacifico Enano Dorado" is expected.

4) Plantains

Plantains have been produced for the farmer's own consumption and for the domestic market. The Government is promoting a plan to increase the production of plantains as an agricultural product for export, because the exportation to the United States has been growing in recent years.

Supporting services have been established by ASBANA and the research aimed at improving the productivity of the plantain has been made. Furthermore, IDA is promoting the production of plantains to the settlement farmers as a recommended crop.

5) Black pepper

Black pepper is a newly-introduced crop in the Study Area. Until now, poor drainage was the major limiting factor for planting it in the Study Area.
Negev settlement located near the Study Area already started the planting of black pepper.

Since black pepper requires an intensive planting system in a small area to keep high productivity, the small-scale farmer is suited for planting this crop. In addition, profit per ha is highest among the proposed crops. The volume of imported black pepper is increasing at a yearly rate of 5%, so that an increase of the production is expected in Costa Rica.

6) Rice

At present, there is a 10% overproduction of rice in Costa Rica. The Government is planning to decrease the cropping area for rice. However, rice is one of the major crops and rice consumption per person has increased 8% annually, from 47 kg in 1980 to 62 kg in 1983.

The present average yield in the Study Area exceeds the national average. With implementation of the Project, increased rice by the improvement of productivity are expected to export.

7) Maize

Maize is one of basic crops as same as rice. 65,000 ton of maize were still imported in 1985, which is equivalent to 40% of the total national demand, though the self-sufficiency rate has improved. Demand rate for maize has increased 8% annually in the last five years.

The Government has been encouraging farmers to grow more maize by establishment of the "Action Plan" and offering a price guarantee. In future, the demand will be expected to increase with the development of livestock in and around the Area.

8) Kidney Beans

Annual demand for kidney beans, one of the basic crops in Costa Rica, is increasing 3%. The government is offering the price guarantee to kidney beans. The 12,000 tons of kidney beans exported last year include the seeds.

The present average yield in the Study Area is less than the national average, but it is possible to increase the yield more than two times by the drainage improvement and technical assistance to the farmers.

9) Tuber Crops

The production of tuber crops such as taro and yam are increasing for export to the United States in recent years.

Planting of tuber crops is suited for the small-scale farmers and a high profit can be expected. Therefore, the Government is planning a new planting area of 1,000 ha in the Atlantic Region, mainly in the Maryland and Negev settlement areas.

10) Livestock (Cattle breeding)

The national consumption of beef cattle increased by 17% in 1986 over 1985 and volume of exports increased 28% at the same time. However, the agricultural investment in beef cattle tends to be restrained, because the marketing price is very changeable. Since it is possible to increase the productivity by the combination of natural and artificial pasture, the Study Area is very favorable for beef cattle production.

(3) Cropping Plan

According to the land use plan, the potential arable land in the Study Area is 44,240 ha. Cropping plan for the cropping area is based on the basic policy of the agricultural production plan and the following considerations:

(1) To give first priority to the cropping plan for the Study Area in the National Agricultural Development Plan.

(2) To consider the elevation (drainage condition) by the crop because the ground water depth varies with the ground elevation even after drainage improvement.

(3) To consider the land classification and adjustment to the soil types to the crop has affected by the soil property. The profitability of the crops by soil property is as shown below.

Table 4.4.2 Profitability of the Crops by Soil Property

Classification (class)	Distribution (El.m)	Soil Type	Soil Texture	Profitability of Crops									
				Banana	Cacao	Coconut	Plantain	Blak Peper	Rice	Maize	Kidney Bean	Tuber	Pasture
II	5~100	AERIC TROPAQUEPT	ALUVIAL	○	○	○	○	×	○	○	○	○	○
		TYPIC TROPORTHENT	LITOSOL	○	○	○	○	○	○	○	○	○	○
III	5~ 30	AERIC TROPAQUEPT	ALUVIAL	○	○	○	○	×	○	○	○	○	○
		TYPIC HYDRAQUENT	GLEY HUMIC	○	○	○	○	×	○	×	×	○	○
		TYPIC TROPAQUEPT	GLEY	○	○	○	○	×	○	○	○	○	○
IV	5~ 30	TYPIC TROPAQUEPT	GLEY	○	○	○	○	×	○	○	○	○	○
VI	30~115	OXIC PALEHUMULT	LATOSOL	×	×	○	○	○	×	×	×	×	○
VII	2~ 10	HEMIC TROPOSAPRIST	TURBOSOL	×	×	×	×	×	○	×	×	×	○
VIII	0~ 2	TYPIC HYDRAQUENT	GLEY HUMIC	×	×	×	×	×	×	×	×	×	×

Note: ○ Profitable
× Difficult

The proposed cropping area based on the above basic consideration is shown in Table 4.4.3. Perennial crops will be introduced in approximately 50% of the Project area; the remaining area will consist of 30% annual crops and 20% pasture land.

Table 4.4.3 Proposed Cropping Area

unit: ha

Crops / Zone	Perennial					sub-total	Annual				sub-total	Pasture	Total
	Banana	Cacao	Coconut	Plantain	Black peper		Rice	Maize	kidney bean	Tuber			
A	1,170	2,230	150	150	0	3,700	1,580	190	100	220	2,090	1,230	7,020
B	2,130	2,880	500	500	180	6,190	2,890	536	329	715	4,470	1,920	12,580
C	1,500	1,670	300	300	400	4,170	430	490	185	415	1,510	1,880	7,560
D	1,200	3,200	850	850	1,080	7,180	1,180	1,475	1,030	2,455	6,140	3,760	17,080
Total	6,000	9,980	1,800	1,800	1,660	21,240	6,080	2,681	1,644	3,805	14,210	8,790	44,240

(4) Crop Yields and Production

Crop production circumstances are expected to be improved by implementation of the Project. In particular, perennial crops such as cacao, coconuts and plantains will display the distinctive character variety by introducing the high yield variety. Therefore, in accordance with the results of the research of MAG, CATIE and ASBANA etc., and the farm management survey, the amounts of the yield will be increased gradually in comparison with the present level. The expected crop yields by the project are summarized in Table 4.4.4.

Table 4.4.4 Proposed Yield Unit: t/ha

Crops \ Yield	Without Project (present)	With Project	* Possible Yield
1. Perennial			
bananas	45.0	49.0	51.0
cacao	0.35	1.0	1.5
coconuts	2.2	10.0	17.3
plantains	5.5	17.0	23.0
black pepper	-	2.2	5.2
2. Annual			
rice	3.0	4.5	8.0
maize	1.2	2.5	6.0
kidney beans	0.5	1.5	1.7
tuber crops	6.0	11.0	14.0
3. Livestock(Cattle)	0.25	0.35	0.42

*ASBANA: SETIMO INFORME DE LABORES DE DIVERSIFICACION AGRICOLA,1985
C.N.P.: AGROTECNICO,1986
SEPSA : COMPORTAMIENTO DE LAS PRINCIPALES ACTIVIDADES PRODUCTIVAS
NICOA : INVERSORA NICOA S Y M, S.A.,1987
BNCR : CONDICIONES DE FINANCIAMIENTOS PARA LOS CULTIVOS,1987

Change in yields by each crop until target yields and the age of the economical production life span of perennial crops are shown in Annex E Table E.10.

The expected total agricultural production in the Project Area for the target year, is calculated on the basis of the proposed cropping area and estimated yields.(see Table 4.4.5).

(5) Farm Management Plan

In the Study Area, bananas plantations and large-scale farmers have established high productivity in agricultural production taking the countermeasures for inundation and drainage problem by their own funds. However, to the small-scale farmers reach 72% of the total farmers in the Project Area, it is difficult to take the same implementation of the agricultural infrastructure and high productivity.

The main objectives of the Project are to increase the income level of small-scale farmers and to improve their living standards. Therefore, the proposed cropping plan has been prepared focusing on the small-scale farmers. In addition, the objectives of the project agree with the supporting policy for small-scale farmers promoted by the Costa Rican Government and the Project will support IDA's settlement program.

1) Farming scale

The average cropping area per farmer in the Project Area is estimated at 2.8 ha (see Table 4.4.6). It ranges between 4.5 ha in Zone A as the maximum and 1.9 ha in Zone D as the minimum.

In this plan, the cropping area will be increased by the project implementation. After the realization of the new settlement project in the Project Area except for Zone B, the number of farmers will be increased by 833, and the average cropping area per farmer increased to 8.3 ha, which is approximately 3 times

more than the present amount.

In this context, the farming scale in the Project will be formulated to coincide with the average cropping area.

Table 4.4.6 Average Cropping Area

Unit: ha

Block		Number of Farmers	Cropping Area per Farmer	Total Cropping Area*
A	Present	514	4.5	2,336
	Project	731	9.6	7,020
B	Present	1,822	2.8	5,168
	Project	1,822	6.9	12,580
C	Present	461	3.8	1,756
	Project	577	13.1	7,560
D	Present	1,619	1.9	3,128
	Project	2,169	7.9	17,080
Total	Present	4,416	2.8	12,388
	Project	5,299	8.3	44,240

* Execluded banana plantation farm

2) Cropping pattern

The cropping pattern has been prepared focusing on the model scale farmers.

Introduced crops have been selected for the Project Area, and based on these crops, the cropping patterns are prepared, and several farm management types are proposed.

The proposed farm management types are established considering the following types with the intention of stabilizing the farm management by the diversification of farm income and mono-cultivation is avoided.

(1) Combination of perennial and annual crops
(2) Rotation of annual crops
(3) Combination of livestock and annual crops
(4) Mono-cultivation of bananas through cooperatives and banana companies

Some perennial crops, in particular cacao, require much labor force during the flowering period for pollination, and during harvesting. The same problem occurs in annual crops during the seeding and harvesting periods. For this reason, it is necessary to consider a combination of crops to minimize the seasonal labor peaks. Moreover, the cropping area of perennial crops which is possible to be managed for one person is limited. In case of annual crops, there exists injury by continuous cropping and reduction of soil productivity by the adoption of year-round cultivation. To avoid this problem annual crops will be rotated. Cropping order and standard rotation of annual crops are proposed a combination of legumes and true grasses such as, rice --- maize --- kidney beans --- tuber crops.

Mechanized farming may solve the problem of low productivity, but it will concentrate the land holdings and reduce the employment opportunities, so that the farm mechanization will be considered in the minimum limit.

In this context, 7 types of farm management is arranged from A to G as follows.

Farm management type		Combination of crops
A	:	cacao + annual crops
B	:	coconuts + annual crops
C	:	plantains + annual crops
D	:	black pepper + annual crops
E	:	rice + kidney beans + tuber crops
F	:	livestock + rice
G	:	bananas

The proposed cropping patterns by farm management type are shown in Fig. 4.4.2.

(6) Production Costs and Producers' Prices

Production costs to achieve the proposed yield have been estimated based on the information prepared by B.N.C.R., and producers' prices have been fixed to coincide with the present level, although producer prices have been rising steadily for the last 7 years. (see Annex E Table E.17)

Proposed production costs, producers' prices and production values per ha are presented in the Table 4.4.7. The breakdown of the production costs are summarized in Annex E Table E.2.6.

(7) Gross Agricultural Production Values

The expected gross agricultural production values in the Project Area are calculated as approximately 8,230million colones (US$ 130 million) (see Table 4.4.8). With the project implementating the gross agricultural production values will be increased approximately 2.5 times in comparison with the situation without the project.

4.5 Road Network Plan

4.5.1 Main Road Plan

(1) Road Network Plan

At present, in the Atlantic Region including the Study Area, there are no roads or bridges in parallel with the coastline crossing the large rivers except for National Route 32. In order to promote the region-wide development, main roads are needed for connecting areas for the transportation of the equipment and materials for agriculturual production to and from the farmlands and the delivery of agricultural products to the markets and processing factories.

Since most of the agricultural products in the Project Area, except for bananas, are collected in Guacimo, and the distance between National Route 32 and the coastline become longer as the National Route runs toward Zone B, C and D - the maximum distance is about 30 km along Rio Reventazon, the main road beginning from the National Route 32, leading to Guapiles and Guacimo via Davao, Bataan and Golden Grove, is planned. (see Fig 4.5.1)

(2) Structure of Main Road

The main road is planned with the shape and structure of a Class-III road with a design traffic volume of 400 - 1,999 cars per day according to the road structure laws of MOPT. (see Fig. 4.5.2)

4.5.2 Trunk Road Plan

(1) Road Network Plan

The trunk roads are planned for the transportation of agricultural products and agricultural production inputs. Roads for circulating inside the Project Area and the connection of National Route 32 and the coast line, making use of the main road network described in the previous clause, are planned as trunk roads. Especially,in order to

reduce the road construction costs, the utilization of existing roads, abandoned railroad and service roads for drainage canals are considered. The planned road network is shown in Fig. 4.5.1.

(2) Shape and Structure of Trunk Road

The trunk road is designed as a Class-IV road with a design traffic volume of 100 - 399 cars per day according to the criteria of MOPT as much as the main road, and shown in Fig. 4.5.3.

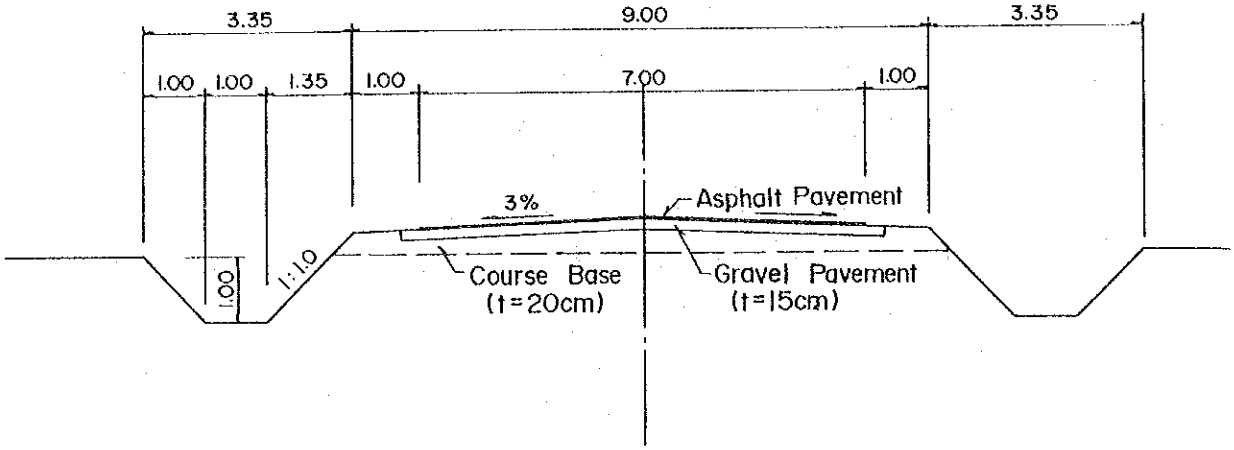


Fig. 4.5.2 Proposed Cross Section of Main Road

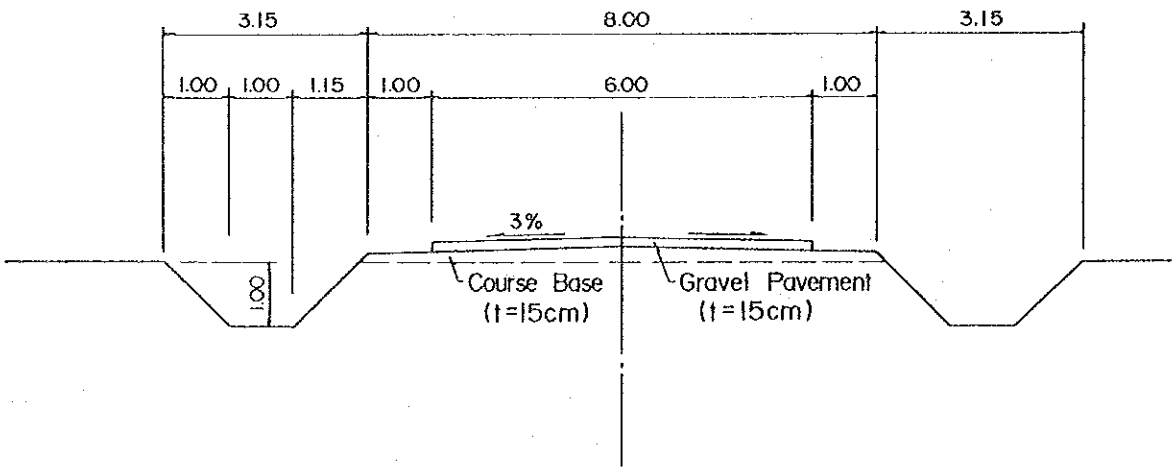


Fig. 4.5.3 Proposed Cross Section of Trunk Road

4.6 Land Consolidation Plan

4.6.1 Basic Policy

(1) Lateral Roads and Drainage Canals

As a general rule, lateral roads and secondary drainage canals are to be arranged at 3.0 km and 1.0 km intervals respectively and be connected to a trunk road and a principal drainage canal.

(2) Drainage of Farmland

The Project Area is relatively flat, and inundation after rainfall will occur due to the topographical undulation. Thus, drainage ditches are to be installed at 40 to 80 m intervals depending on the kind of crops to be planted and the soil.

(3) Ordinary Groundwater Table

Ordinary groundwater tables to be controlled in the farmlands differ in the kind of crop. Those for perennial crops and annual crops are as follows:

(A) Perennial crops : 1.0 m below ground surface

(B) Annual crops

(a) Upland field: 0.6 m below ground surface

(b) Rice paddies: 0.5 m below ground surface

4.6.2 Land Arrangement

(1) Standard Block

Since the shape and size of a field block are assumed to average 100 x 1,000 m or 200 x 500 m (10 ha) according to the situation of the landholding, the standard area of a farm block will be 500 x 1,000 m (50 ha). Accordingly, a block, which is a unit on the cultivation and management unit, will be 1,000 x 1,000 m (100 ha) as shown in Fig. 4.6.1.

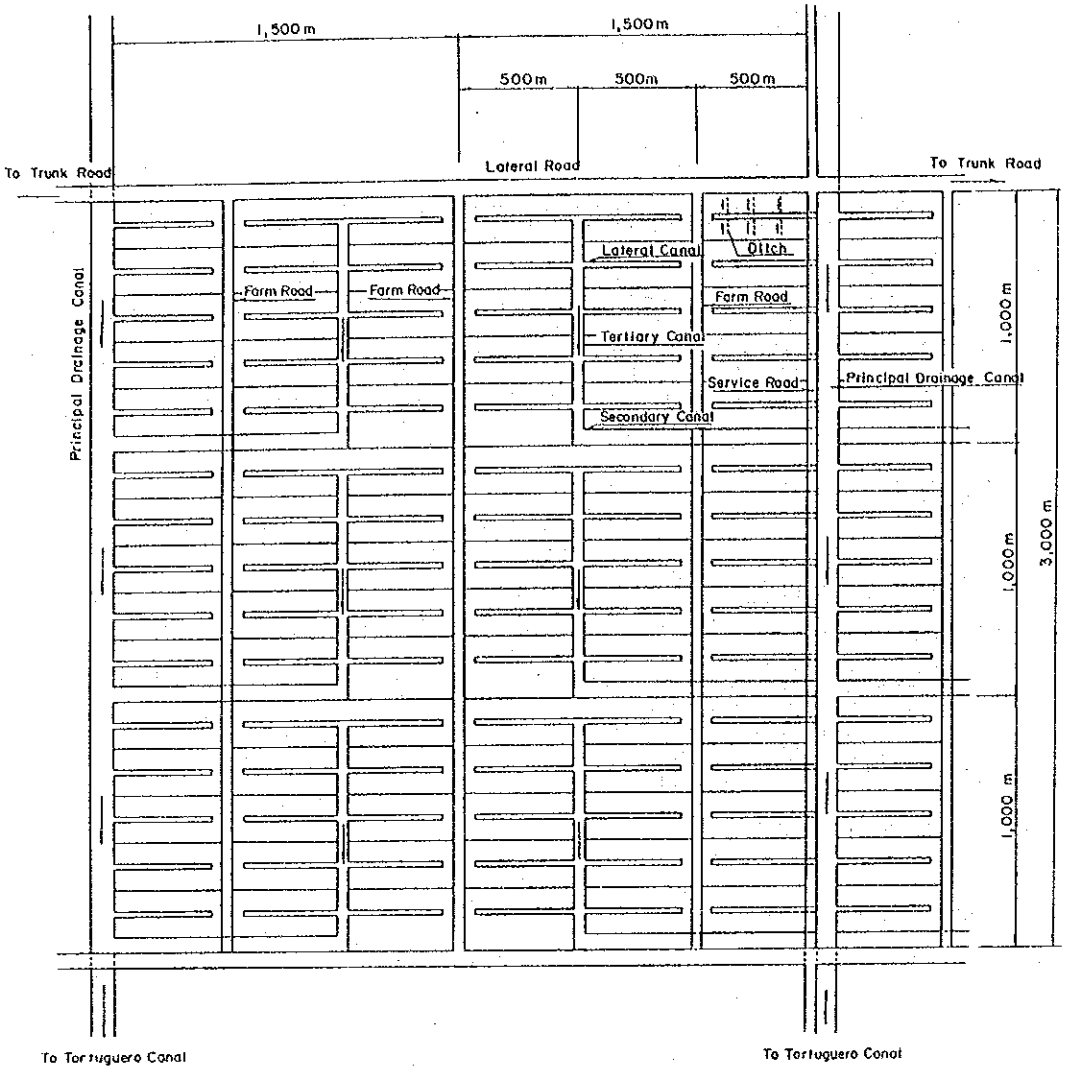


Fig. 4.6.1 Standard Layout of Drainage Canals and Roads in Farmland

(2) Plan of Ditch

The layout of ditches in a field block is decided by the kind of crop and soil, taking into account the groundwater tables to be controlled and the layout of ditches are shown in Fig. 4.6.2 and 4.6.3.

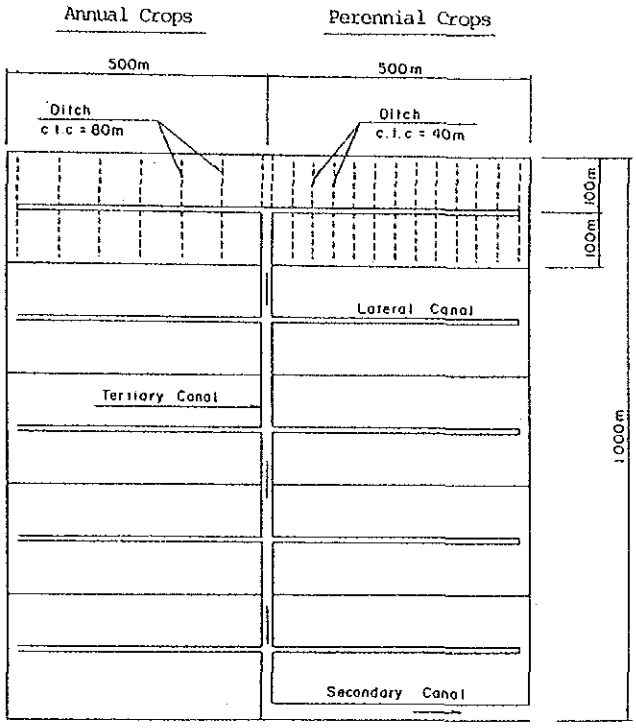


Fig. 4.6.2 Standard Layout of Field Block in Farmland

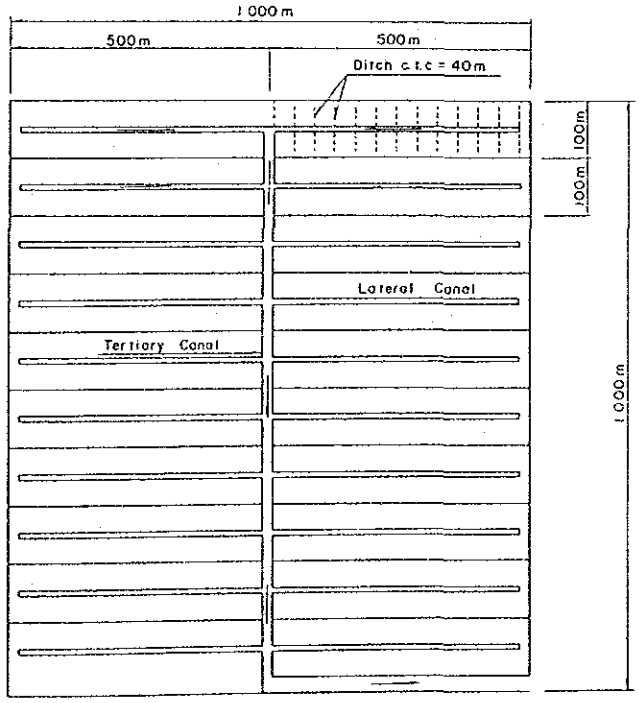


Fig. 4.6.3 Standard Layout of Field Block in Banana Plantation

4.6.3 Farm Road and Drainage Canal

(1) Farm road

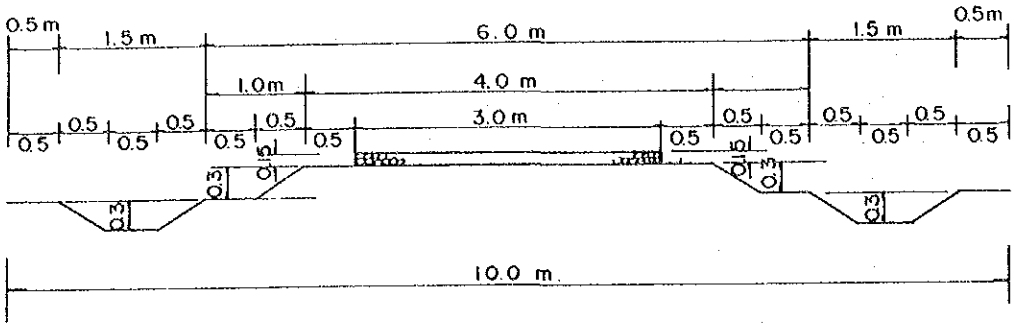


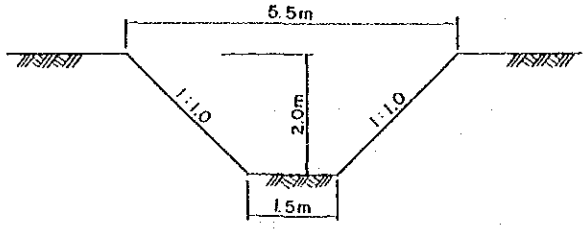
Fig. 4.6.4 Proposed Cross Section of Farm Road

Total width of road : 4.0m.
Available width of road : 3.0m. (0.15m thick gravel pavement)
Bank Height : 0.3m.
Side ditch : upper width 1.5m, bottom width 0.5m, depth 0.3m.
Site width : 10.0m

(2) Drainage Canal

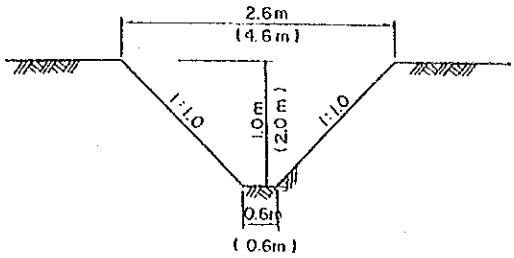
1) Tertiary drainage canals

Common for all crops



2) Lateral Drainage Canal

(a) Case for Perennial Crops



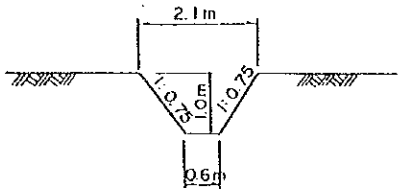
Canal Intervals

Banana Plantations : 100 m

Others : 200 m

(b) Case for annual crops

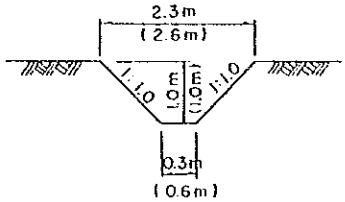
Canal Interval : 200 m



3) Ditch

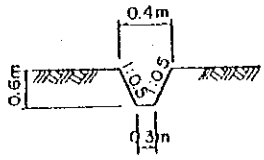
(a) Case for Perennial Crops

Ditch Intervals : 40 m



Note: Values in parentheses indicate banana plantations

(b) Case for Annual Crops



Ditch Interval : 80 m

4.7 Settlement and Rural Development Plan

4.7.1 Settlement Plan

(1) Selection of Settlement Area

Based on present land holdings, existing settlement, land classification maps, soil maps, and land-use maps, available areas for new settlements in the Project Area are estimated at approximately 11,500 ha in total. As described in Section 3.7, most of these areas are illegally cultivated areas and grasslands; the unexploited land area is extremely small. The available areas for new settlements are listed in Table 4.7.1 (also, see Fig. 3.7.1).

Table 4.7.1 Proposed Settlement Area

Zone	Area	Available Land (ha)		
		Cultivated Land	Uncultivated Land	Total
A	I	2,360	460	2,820
B	-	-	-	-
C	II	660	850	1,510
D	III	4,430	2,720	7,150
Total		7,450	4,030	11,480

(2) Size of Field Block

The size of field block lot is planned as 10 ha on an average for a ordinary farmer in the settlement project executed by IDA, and as 15 ha on average for a livestock-farmer.

883 farm households to be settled are planned in the future for the proposed settlement area of 11,480 ha.

(3) Settlement method

IDA's settlement procedure methods, such as screening applicants and selecting qualified settlers, present no problems and are well adapted to the area. Therefore, the IDA method is adopted in the settlement plan.

Drainage ditches and farm roads shall be designed and constructed based on the criteria established in this master plan.

The scatter type is to be used for housing, since the settlers are not accustomed to colony type in the present conditions.

(4) Housing

Recent housing in the settled area is built with the financial assistance from IDA. The standard house is a wooden house of 36 m^2 in total with two bedrooms, a living room and a kitchen.

(5) Public facilities

Public facilities are to be provided in the new settlement areas. These facilities will be built independent from those existing in surrounding communities. A management office and the following facilities are to be built.

Clinic:	One building	50 m^2
Public Hall:	One building	100 m^2
Primary School:	One building	300 m^2
Lodging for Teachers:	One building	60 m^2
Water Supply Facilities:	One set	
Athletic Field:	One field	

4.7.2 Rural Development Plan

Rural development plan is to realize a conception, in executing the various programs, to improve the inhabitants' living standards (production, daily existence, education, welfare, public activities, etc.). A rural development plan comprises of a district, town, or several villages.

Villages in the Project Area are developed around banana plantations. These types of villages can be seen in existing settlement areas of IDA.

In existing villages, the numbers of schools and clinic are sufficient, however, public halls and lodgings for teachers are inadequate. Accordingly, these facilities will be arranged up to the same level as in the new settlement area.

As it is clear in the results of the study of well water which is now used as drinking, it is not good. Thus, low cost water works and sewers of permeation type for farmhouses will be planned in the Project Area.

Siquirres, Matina, and Limon cantons have urban areas. Population in these cantons is shown in Table 4.7.2.

Table 4.7.2 Distribution of the Population in the Project Area

Country	District	Population			Remarks
		Town Area	Rural Area	Total	
Siquirres	Siquirres	7,146	10,376	17,522	
	Pacuarito	-	4,357	4,357	
	Florida	-	1,794	1,794	Not included in Study Area
	Germania	-	2,995	2,995	"
	Cairo	-	2,411	2,411	"
	Sub total	7,146	21,933	29,079	
Matina	Matina	1,102	2,862	3,964	
	Bataan	-	6,712	6,712	
	Carrandi	-	4,047	4,047	
	Sub total	1,102	13,621	14,723	
Limon		33,925	18,677	52,602	
TOTAL		42,173	54,231	96,404	

These three urban areas and villages that have developed around the banana plantations are the center of rural communities in the Project Area.

Existing settlements are scattered type. Each community has, at most, 20 to 40 families, and there are only limited facilities available that are necessary for farming and daily life.

Housing, drinking water, electricity, a primary school, and a traveling medical clinic have been provided during the early stages of settlement. However, communication systems to urban areas, roads to transport agricultural products, and transportation means are still insufficient. Improvements of roads, and communication and transportation means are important in the future rural development program.

Change of crops in existing settlement areas

As described in 4.7.1, though no new settlement plan exist in Zone B, some farmers of Bataan area want to change crops from annual crops to bananas. If farmers in a group change crops, it would be necessary to rearrange drainage canals, roads, and communities.

4.8 Agricultural Promotion Plan

4.8.1 Strengthening Plan of Agricultural Supporting Organization

The integrated agricultural development plan is based on the production of traditional and non-traditional crops. In order to secure the high productivity in agriculture, the improvements in various aspects, such as extension service of farm technique, basic condition of farmland, agricultural financing condition, and marketing system are needed. For the smooth implementation of these improvements, it is important to strengthen the agricultural supporting organizations so as to have close relations among administration, experimental and research organization, farmers' organization and farmers.

The existing agricultural support organization will be more greatly utilized and the following improvement will be proposed.

(1) Agricultural Technical Committee by Experiments

Existing experimental and research organizations such as ASBANA, CATIE, Agricultural Experiment Station of the University of Costa Rica and Agricultural Experiment Station, operated in cooperation with the Republic of China, as mentioned in 3.4.6(2) " Experiment and Research", well-handled to all problems concerned in agriculture. The establishment of a new experimental station is considered to be unnecessary in this project.

However, it seems that the guidance and extension of farming techniques such as improvement of species, cultivation and countermeasures against disease and injury is required. The establishment of the "Agricultural Technical Study Committee" (tentative name), centering around newly established project office is proposed for enhancement of the extension sector, of which members are from administration (from each Ministry's Experimental Organization) and agricultural cooperatives.

(2) Strengthening of Agricultural Extension Services

The agricultural extension services of IDA and MAG would be strengthened. The scheme aims to increase the number of extension worker and provide adequate transport, as well as to provide an extension audio-visual car. It also aims at training the extension worker at the existing facilities of the Tropical Agricultural Research and Training Center (CATIE), and the University of Costa Rica.

Extension services in the Project Area are managed by the Atlantic Regional Office of MAG, which covers the whole Limon province. Its 40 members include agricultural specialists, as well as an extension worker and clerk.(see Annex H Table H.5.1)

The Atlantic Regional Office in Siquirres has a district branch office and their field operations are spread over the Cantonal area. However, both regional and district offices had been unable to provide smooth extension activities due to a shortage of extension workers and material and equipment for their works.

The IDA extension services in the Project Area are operated and managed at Maryland (the Canton of Siquirres) office with the staff.(see Annex H Table H. 5.1) However, the extension services for the farmer are not functioning due to the shortage of staff and lack of extension facilities, except for new settlement area such as Maryland. Strengthening of the agricultural extension services of IDA would also include vehicles, audio-visual car and extension staff.(see Annex H Table H.5.2)

4.8.2 Improvement of the Farmers' Organization

(1) Agricultural Production Cooperatives

New agricultural cooperatives for cacao and tuber crops will be

established and the facilities to be needed for the cooperatives will be provided by the Government funds, aiming at the year 2000.

1) Establishment of the cacao post-harvest cooperative facilities for the producer's management cooperatives, with investment by the government (8 post-harvest cooperatives and facilities at the first stage).

2) Establishment of tuber crop and coconut export marketing cooperatives with facilities for the producer's management cooperatives, with investment by the government (8 root crops cooperatives and facilities).

New cooperative organizations for cacao cooperatives, tuber crop and/or coconut would also be established under the direction of the INFOCOOP.

These new cooperative organizations will have the following requirements:

1) A farmer, who produces crops with more than 0.1 ha cultivation for each crop would become a member of this new cooperative organization.

2) Members must purchase production materials handled through the cooperatives.

3) Members must sell through the cooperatives.

4) Members must create special deposit of 10% as a reserve fund from production, in order to deal with fluctuating market prices.

5) Non-farmers could become associate members of this new cooperative organization, by purchasing "fixed amount of shares" and "money on deposit".

6) A local brokerage could become an associate member of this new cooperative organization and handle transportation for production of the cooperatives.

7) A manager who is elected by members appoints staff in charge of accounts, sales and purchases as well as other necessary staff to operate the cooperatives.

(2) Development Association

Existing associations, such as a development association, are organized in village units, but membership is very low at about 30% only. The development program of the association is made plans for all inhabitants. From this end, all inhabitants should participate in the association.

The representative will receive the guidance of DINADECO and do their efforts to obtain the national budget. The inhabitants participating in it will bear membership fee and their own force, which is necessary for the regional development activities and their own work force.

4.8.3 Agricultural Industry and Marketing Facilities Plan

(1) Plan for Establishing Cooperative for Banana Production

The most appropriate scale for a cooperative for banana production is 250 to 300 ha composed of 25 - 30 farmers, considering its actual activities (the scale of a banana plantation promoted by ASBANA is 250 ha). By the year 2000, two cooperatives will be established in each of Zones A, B, C and D in accordance with the cooperative method. The operation will be the same as that of "Coop Bataan" (See Annex H Fig. H.3).

Other banana plantations will manage by the local enterprises participating in ASBANA.

The cropping plan of cooperatives for banana production and banana plantations is as follows:

Zone	No. of Coopera-tives	Banana Production Area		
		Coopera-tives(ha)	Domestic Companies(ha)	Total(ha)
A	2	500	202	702
B	2	600	678	1,278
C	2	600	300	900
D	2	500	220	720
Total	8	2,200	1,400	3,600

(2) Establishment of post-harvest facilities for cacao

Cacao seeds production of Costa Rica in 1986 was about 3,800 tons. In the Project Area, the production is about 1,100 tons from cultivated area of about 3,360 ha. The average production is only 0.35 tons per ha.

Cacao production will gain 10,000 tons from 10,000 ha in the year 2000, and the average production will rise to 1.0 ton per hectare. The present cacao-farmers habitually practice post-harvest for fermentation and drying on the ground under natural conditions. They have no facilities for all-weather fermentation and drying facilities. Therefore, the produced dried cacao seeds have deteriorated in quality caused by churning from fermentation.

Although traditional natural drying is practiced, farmers find it difficult to dry to 7-9% moisture due to much rainfall in the Area. Sometimes, products are difficult to sell, being damaged by mold or rotten.

In this Project, post-harvest facilities would be established under the direct management of the cacao production cooperatives. Optimum scale of cacao cooperative with one post-harvest facility is 80 - 100 farmers in member and 500 ha in an area. The cacao producer has about 1,700 farm families in the Project Area. The average cultivated area is about 2.5 ha per farmer. Finally, 20 cacao production cooperatives with 20 new post-harvest facilities will be established.

Table 4.8.1 Post-Harvest Facilities Plan of Cacao

	First Stage (1990)	Second Stage (1995)	Final Stage (1998)	Total
No. of Coop.	8	8	4	20
Cultivation (ha.)	4,000	4,000	2,000	10,000
Post-harvest facilities	8	8	4	20

First stage of this post-harvest facilities will be implemented by the government in 1990, and the cooperatives will pay within a period of 5 years at no interest.

Second stage facilities will be implemented by the first stage withdrawal fund again in 1995. The final stage in 1998 will be implemented by second stage withdrawal fund. A surplus fund in this term will rotate in the operation and maintenance for the facilities which were constructed in the first, second and final stages. (see Annex H Table H.5.3)

Main processing facilities (per cooperative) are as follows:

1)	Fermentation box	0.3 m^3 x 1,000 box
2)	Fermentation house	60 m^2
3)	Drying facilities	1 unit
4)	Covered drying yard (all weather drying facilities)	180 m^2
5)	Packing facilities and moisture tester, etc.	1 unit

(3) Processing Facilities Plan for Tuber Crops

The processing facilities of exported coconut/tuber for washing, drying, quality choice system, packing and transportation are established by each cooperative.

Main processing facilities (per cooperatives) are as follows:

1)	Washing facilities and selector	: 1 unit
2)	Drying yard and all weather drying system house	: 1 unit
3)	Weighing and packing equipment	: 1 unit
4)	Transportation tracks (4 tons capacity)	: 1 unit

The construction and operation of these processing facilities is carried out by the tuber crop production cooperatives. The funds for these facilities are assumed to be government funds. (see Annex H Table H.5.3)

At present, the market for agricultural products is held weekly in Siquirres and Bataan. However, it is planned that the facilities for standing market will be established in order to increase the production of the agricultural corps, expand the marketing channel and vitalize the regional economy.

(4) Farm Machinery Center Plan

Small farmers in the Project Area own farmland of about an average of 10 ha. Without tractors, farmers could not fully utilize their large scale farmlands. A farmer cannot afford a tractor. The farm machinery center plan which will be formulated mainly for cultivation of farmlands, is treated as one of the basic project components of the Limon Integrated Agricultural Development Project.

A farm machinery center will be established for each 5,000 to 6,000 ha of farmlands. IDA or new cooperatives will be responsible for its operation and management.

Two farm machinery centers will be established in 1990, four in 1995 and two in 2000. The fund necessary for the above is to be financed by the government and its estimated amounts are indicated in Annex H Table H.5.3.

Each farm machinery center will be equipped with;

1)	Tractor (With harrow, plough and trailer)	43 Hp	5 units
2)	Bulldozer	11 tons	1 units
3)	Medium size combine for paddy cropping		2 units
4)	Workshop	225 sq.m.	1 unit
5)	Tools		1 unit

CHAPTER 5 PROJECT IMPLEMENTATION PLAN

Chapter 5 Project Implementation Plan

5.1 Basic Policy for Project Implementation

With the implementation of Integrated Agricultural Development in this area, it would be ideal to carry out every project mentioned above at one time. However, considering the extensive scale of the Project Area (67,000 ha), both quantity and cost of the project are estimated to be enormous, and the method to execute the whole project at one time cannot be applied in Costa Rica. Accordingly, it is advisable to phase this project.

In the case of phased implementation, studying the effects of each project, it would be possible to begin with a project which has an excellent effect following priorities. However, in this area, it is considered to be effective to some extent but more risky as an investment to cover the whole area with only one project. For example, if drainage canals are constructed in uncultivated areas, full maintenance cannot be always expected, but the drainage canals will become obsolete at the time of conversion of the nearby property into farmland and the repair will be inevitable.

Consequently, in the development of this Area, the method of phased implementation, not for the whole area at a time, but from zone to zone will be applied.

5.2 Selection of Preferred Area

The preferred area is model area for feasibility study and also pilot area for the farmland development plan in the Atlantic Region in Costa Rica, for which the possibility of earlier realization is of importance. The four divided zones mentioned earlier will respectively be evaluated (economically, socially and technically). Though a preferential order will be decided fundamentally putting stress on economical propriety (estimated construction costs, internal rate of retun), meanwhile the following factors are also completely studied.

Table 5.1.1 Selection of the Area with a High Priority

Zone	Area	Population	Land Ownership					Farming Scale			Landuse		Area Necessary for Improvement in Drainage				Actual Infrastructure						Farming Condition		Construction Cost	Economic Evaluation			Conclusion
	Total Area / (Available Area)	Total / Urban / Rural	Private Land: IDA'S Settlement	Private Land: Banana Plantation	Private Land: Others	National: IDA / JAPDEVA	Priority	No. of Families	Ratio of small farmer	Priority	Ratio of Agricultural Landuse	Priority	Over GH 10 m / Under 10 m	Poor Drainage Area	Total	Priority	Canal Extension	Small River Extension	Total	Priority	Route No.32 / Road within zone	Priority	Distance to Route No.32	Priority	Project Cost / Project Cost per ha.	IRR	Priority		
A CARRANDI	Ha 10,800 (10,400)	hab. 4,847 (11%) 0 4,847	Ha 3,560 (34%)	Ha 1,100 (11%)	Ha 4,900 (47%)	Ha 0 840	②	house 514	% 58	③	22 % 29 24 73 %	④	Ha 2,250 5,090	Ha 380	Ha 7,720 (74%)	①	Km 12 1.2 km per 1000ha	Km 41	Ha 53 5.1 km per 1000ha	②	Km (Asphalt 6m) 18 26.4 Km 2.5 km per 1000 ha	③	Km San Edmondo Km 7	①	10^3 us$ 14,680 us$ 2,891	21.7%	③	④	
B BATARN	19,500 (19,000)	10,676 (29%) 1,100 9,576	9,930 (52%)	1,870 (10%)	6,160 (32%)	0 1,840	①	1,822	78	①	24 21 17 82 %	①	2,400 5,620	3,010	11,030 (58%)	②	Km 82 4.3	72	Km 160 8.4	①	9.2 80.5 (4.2)	②	Santa Marta 12	②	24,369 1,937	25.4%	①	①	
C PACUARITO	12,600 (11,900)	4,357 (12%) 0 4,357	1,310 (10%)	1,810 (14%)	5,970 (50%)	0 2,810	④	461	48	④	17 24 25 66 %	②	3,560 2,230	0	5,790 (44%)	④	Km 29 2.2	46	Km 75 5.7	②	18.1 28.6 (2.2)	④	Perla 13	③	16,998 2,248	22.8%	②	③	
D SIQUIRRES	24,100 (23,200)	17,522 (49%) 7,146 10,376	4,800 (18%)	2,960 (13%)	7,910 (34%)	2,800 6,430	③	1,619	56	②	23 22 26 69 %	③	4,740 6,900	0	11,040 (50%)	③	Km 5 8.2	69	Km 74 3.4	④	5.1 97 (4.4)	①	Maryland 22	④	33,254 1,948	20.5%	④	②	
Total	57,000 (54,500)	36,682 (100%) 8,246 28,356	(29%) 18,800	(12%) 7,640	(39%) 24,940	(20%) 13,120		4,416	68		66 %		32,190	3,390	35,580 53		Km 128	Km 234	Km 362		Km 40.7 233				89,309 2,819	22.5%			

The preferred conditions are as follows:

1) To have more land already developed than that of the new development.
2) To have drainage canals and roads already developed and mainatained to some extent.
3) To have many settled farmers who have farming technology.
4) To have a high degree of ownership and settlement registered.
5) To have many medium- and small-scale farmers.
6) To have a demonstration effect and to influence the neighboring districts in development effect.
7) To be urgently needed and to be promptly effective.

The results of our study on the characteristics of each zone and development plan mentioned in the preceding chapter, indicate the following priority order as shown in Table 5.1.1.

First	Zone B
Second	Zone D
Third	Zone C
Forth	Zone A

5.3 Organization for Project Implementation

In the implementation of this project, it is advisable that SENARA, IDA, MAG and JAPDEVA have an interrelationship and jointly set up a board for this purpose, to make decisions for the whole project. SENARA is in charge of the project implementation. SENARA is a much experienced organization set up for planning and executing irrigation and drainage. Supporting organizations are CNP in production, SBN in finance and credit, as well as MIDEPLAN in coordination for the agriculture development project of Atlantic Region.

The organization is constituted as follows:

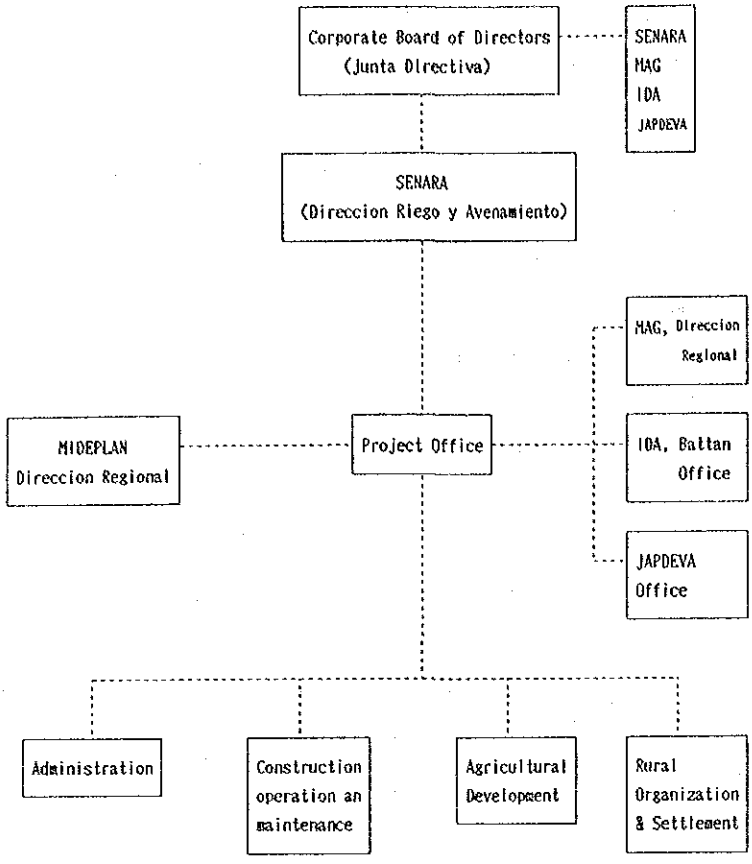


Fig. 5.3.1 Project Organization Chart for Implementation

5.4 Operation and Maintenance Plan

5.4.1 Basic Policy

After completion of the project, if facilities are not accurately maintained and administrated, the estimated effectiveness could not be attained. Especially, in this Area, owning to weather conditions (high temperature and much rain), it is requested that drainage canals and roads be maintained and accurately controled. In this plan, the basic policy for operation and maintenance of facilities is as follows:

River : Under MOPT's control

Principal and Secondary drainage canal : Under SENARA's control

Main roads within	:	To be transferred to MOPT which will be the district in charge
Branch roads	:	To be transferred to the cantons
Lateral drainage canals	:	Under the control of an administration cooperative formed by farmers.
Farm roads	:	"

5.4.2 Administration System

The project office will be replaced by an administration office under the control of SENARA. In each zone, a substation will be opened. An administrative association will be established in each zone and a substation in each community as well as in each settlement.

The machines to be provided within each administration substation are a dragline, 4 bulldozers, 4 backhoes, 4 dump trucks and 4 jeeps.

5.5 Implementation Schedule

5.5.1 Overall schedule

The period should be decided judging integratedly from the financing capacity of the project budget, and the executive and administrative capacity for the project by the authorities concerned. As to capacity, it is considered that the implementation becomes more confident the more inclined will be to do it. However, on the other hand, in order to save medium and small farmers who suffer from poor drainage, the shorter implementation period will produce the higher effect.

Considering the national budget etc, these factors should be fully studied. At this stage, it is scheduled to last twelve and half years

including the period of detailed design as follows.

Table 5.5.1 Implementation Schedule

	87	88	89	90	91	92	93	94	95	96	97	98	99	2000
A Zone Detailed Design											---			
A Zone Construction												———	———	———
B Zone Detailed Design		------												
B Zone Construction				———	———	———								
C Zone Detailed Design								------						
C Zone Construction										———	———	———		
D Zone Detailed Design					------	------								
D Zone Construction							———	———	———					

Note: Finance, survey, detailed design and tender are included in the period of detailed design.

5.5.2 Project Implementation Method

In relation to the national budget and the budget during implementation, it is of importance that construction work will be carried out evenly over the years. In order to have an increased effect on the facilities constructed and to maintain the facilities after completion the job division of lots should be fully studied and executed.

In this project, the following order of implementation is desirable for each job zone.

1) Flood protection work (to be executed from down to upper stream)
2) Principal drainage canal work (- ditto -)

3) Main and trunk road work
4) Secondary, tertiary and lateral drainage canal work
5) Lateral and farm road work
6) Public facility work within planned settlement area

Note: 4) and 5) should be contracted simultaneously as the land consolidation work.

The project is scheduled to begin with the Zone B, followed by the Zone D, and the following facilities should be implemented at the same time as Zone B and Zone D.

Dike on the right bank of the Rio Matina	:	At the implementation of the project in Zone B
Principal Drainage Canal No. C-1 (Rio Madre de Dios)	:	- ditto -
Dike on the right bank of the Pacuare	:	At the implementation of the project in Zone D

5.6 Estimated Construction Costs

5.6.1 Premise

The premise for cost estimates are as follows:

(1) Time of cost estimates and rate of exchange

As of May, 1987 and US$1.00 - ¢61.30

(2) Unit price to be employed

The unit prices which SENARA uses and those which MOPT and IDA used in the investigation of neighbourhood area will be employed. Overhead charges (36.5%) and reserve funds are also included in the unit prices.

(3) Price contingency

BID's prices (13.7%) used for the Arenal Tempisque Project will be employed.

(4) Foreign and local portions

Civil work in general : depends on the portion of foreign and local currencies by which typical machinery and materials are purchased.

Settlement for public facilities is all in local currency.

Purchase expenses for land : all in local currency

Detailed design and supervision expenses : all in local currency.

(5) Scope of Estimation

The scope of estimation includes flood protection and improvement for both drainage and roads, including the imporvement of roads and drainage canals in the formland as well as the public facilities in the new settlement. However, the following works are not included; land purchase expenses for settlement and construction cost of farmland ditches.

5.6.2 Estimated Construction Cost

The estimated construction cost for each zone is indicated in Table 5.6.1. For the whole area, it amounts to US$89,309,000 (US$61,988,000 in foreign currency and US$27,321,000 in local currency), including price contingency.

Construction cost per ha is US$2,019 for 44,240 ha, which is calculated by deduction of 7,640 ha for the existing banana plantations from 51,880 ha for the whole Study area.

CHAPTER 6 PROJECT EVALUATION

Chapter 6. Project Evaluation

The objective of this chapter is to select an area for feasibility study which will be executed succesively from the master plan study of the project, after decision of the priority order for the project implementation from among the four zones which are proposed in Chapter 4.

6.1 Economic Evaluation

6.1.1 Benefit

The expected benefit of the Project consists mainly of increase in crop production and saving in cost of transportation by road construction and improvement.

Increased value of crop production (target year) in each zone is estimated as follows:

(1) Zone A

Unit: ₡ 1,000
(US$ 1,000)

Item	Without Project	With Project	Increased Value
Gross value of production	153,587 (2,505)	1,166,720 (19,033)	1,013,133 (16,528)
Production cost	123,100 (2,008)	651,083 (10,621)	527,983 (8,613)
Net value of production	30,487 (497)	515,637 (8,412)	485,150 (7,915)

(2) Zone B

Item	Without Project	With Project	Increased Value
Gross value of production	310,769 (5,070)	2,486,986 (40,571)	2,176,217 (35,501)
Production cost	244,777 (3,993)	1,227,591 (20,026)	982,814 (16,033)
Net value of production	65,992 (1,077)	1,259,395 (20,545)	1,193,403 (19,486)

(3) Zone C

Item	Without Project	With Project	Increased Value
Gross value of production	81,944 (1,337)	1,358,131 (22,155)	1,276,187 (20,818)
Production cost	63,197 (1,031)	730,091 (11,910)	666,894 (10,879)
Net value of production	18,747 (306)	628,040 (10,245)	609,293 (9,939)

(4) Zone D

Item	Without Project	With Project	Increased Value
Gross value of production	153,531 (2,505)	2,183,621 (35,622)	2,030,090 (33,117)
Production cost	122,164 (1,993)	1,157,856 (18,888)	1,035,692 (16,895)
Net value of production	31,367 (512)	1,025,765 (16,734)	994,398 (16,222)

Saving in cost of transportation for agricultural products and farm inputs by road construction and improvement of the Project is calculated as follows:

Unit: 1,000 US$

Year	A	B	C	D
1	7	44	7	94
2	22	134	22	192
3	23	144	23	240
4	24	147	24	249
5	24	150	24	257
6	24	150	24	259
7	25	152	25	266

6.1.2 Project costs

Project costs involve construction and engineering service costs. The annual disbursement schedule of the project costs of each zone is as follows:

Unit: 1,000 US$

Year	A zone	B zone	C zone	D zone
1	307	390	253	664
2	2,132	390	253	2,473
3	5,780	6,464	4,834	11,634
4	4,692	10,106	4,612	4,199
5	-	4,081	4,998	6,803
Total	12,911	21,431	14,950	25,773

On condition that the construction cost for flood protection of the left bank of Rio Reventazon (outside of the project area) in zone D is excluded.

6.1.3 Internal rate of return and net present value

Based on the benefit and costs as mentioned above, economic rate of return is calculated under the assumption that project life is 50 years and the target year will be set up for each crop after completion of the Project.

The results are as obtained below.

Zone A : 21.7%
Zone B : 25.4%
Zone C : 22.8%
Zone D : 20.5%

The benefit-cost ratio (B/C) at 8, 12 and 18% discount rate and the net present value (NPV) of each zone are included in the following table.

	B/C (Discount rate)			NPV (1,000 US$) (Discount rate)		
Zone	8%	12%	18%	8%	12%	18%
A	1.49	1.32	1.11	43,114.30	17,809.70	3,591.01
B	1.67	1.48	1.24	101,349.00	43,822.50	12,225.00
C	1.49	1.34	1.14	50,815.30	21,130.90	4,832.88
D	1.48	1.30	1.08	78,431.60	30,616.40	4,664.25

As a result, B sub-area is highly rated in terms of the EIRR. And this sub-area is superior to the other zone because of high value with respect to NPV and B/C. Hence a higher priority has been given to B zone.

Furthermore, the other zones have high viability as agricultural development project in view of the results of the EIRR.

6.1.4 Sensitivity analysis

Sensitivity analysis has been made in the event of a variation in project costs and benefits (price or yield).

Variation	Zone : A	B	C	D
(1) A 20% increase in construction cost	19.9%	23.4%	20.9%	18.9%
(2) A 10% reduction in benefit	17.9%	21.7%	18.9%	17.1%
(3) A combination of (1) and (2)	16.5%	20.0%	17.3%	15.8%

It is clear that the economic evaluation of the project is affected more severely by a decrease in the benefit (price or yield) than by an increase in the project cost.

6.2 Financial Analysis

The project costs, including price contingency, consist of foreign and local currencies. If the construction is carried out as scheduled in 5.5 of the foregoing chapter, annual disbursement of the project costs in each sub-area is proposed as follows:

Unit: 1,000 US$

Year	Zone A			Zone B		
	Project cost	L/C	F/C	Project cost	L/C	F/C
1988	-	-	-	443	-	443
89	-	-	-	443	-	443
90	824	325	499	7,350	2,271	5,079
91	824	325	499	11,491	3,514	7,977
92	-	-	-	4,640	1,355	3,285
93	-	-	-	-	-	-
94	-	-	-	-	-	-
94	-	-	-	-	-	-
95	-	-	-	-	-	-
96	-	-	-	-	-	-
97	349	-	349	-	-	-
98	2,424	621	1,803	-	-	-
99	5,748	1,747	4,001	-	-	-
2000	4,511	1,378	3,133	-	-	-
Total	14,680	4,396	10,284	24,367	7,140	17,227.pa

Year	Zone C			Zone D		
	Project cost	L/C	F/C	Project cost	L/C	F/C
1988	-	-	-	-	-	-
89	-	-	-	-	-	-
90	-	-	-	-	-	-
91	2,767	830	1,937	857	-	857
92	1,220	520	700	3,966	1,308	2,658
93	2,843	1,206	1,637	15,815	5,407	10,408
94	288	-	288	4,833	1,303	3,530
95	288	-	288	7,793	2,424	5,369
96	2,729	802	1,927	-	-	-
97	4,023	1,144	2,879	-	-	-
98	2,840	841	1,999	-	-	-
99	-	-	-	-	-	-
2000	-	-	-	-	-	-
Total	16,998	5,343	11,655	33,264	10,442	22,822

Assuming that the foreign currency portion of the project cost will be financed from an international monetary institution and the remainder is assumed to be covered by the government.

The reimbursable cost is calculated on the assumption that the foreign currency portion of the project costs will be procured under the following conditions.

The results are shown in table 6.1.1.

Loan conditions

Annual Interest Rate	: 4%
Loan Period	: 25 years
Grace Period	: 5 years
Amortization	: 2 repayments annually with constant amount uniformity of the principal

6.3 Financial Analysis of Farm Households

6.3.1 Profit and loss

In consideration of existing farming patterns, farm scale and local conditions, the farm management of model farmers at the target year will be calculated in case of farm management under the proposed farming pattern.

Assuming that the following conditions for the profit and loss calculation are;

- The agricultural products for self-sustenance are deducted from the amount sold.
- The cost of family labor is excluded from the production costs.
- The interest for farm credit is set at 24% for the short term and 15% for the long term, and the borrowing terms are based on the loan conditions of BNCR.

The results of these calculations are shown in Table 6.1.2 and as the farming conditions of model farmers make rapid improvement. Further the model farmer mainly growing perennial crops is expected to make a farming profit from 5 years after completion of the Project.

6.3.2 Possibility of burden for maintenance and withdrawal changes

After the Project has been carried out, if SENARA collects the project costs in the shape of charge from the beneficiaries, the water charge is estimated as follows;

(1) Operation and maintenance cost

Total cost of operation and maintenance after completion of the Project is estimated at US$647,600 annually on the average, which is equivalent to US$13 (¢800) per hectare.

(2) Withdrawal cost

Annual withdrawal cost equivalent to a burden of the project costs by the beneficiaries US$16,358,000 is estimated US$15 per hectare considering similar projects for agricultural development in Costa Rica.

From the above, the maintenance and withdrawal charges equivalent to US$28 (¢1,716) per hectare including both operation and maintenance costs and withdrawal cost appear to be adequate.

It is expected that the beneficiaries will be able to bear the estimated water charge from 8 years after completion of the Project in view of the model farmer's financial situation.

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

Chapter 7 Conclusions and Recommendations

7.1 Conclusions

Based on the study of the necessity of development of an area of 67,000 ha (agricultural land for development : 44,240 ha) and the basic concept for development from the social, economical and technical view point, the following conclusions are attained.

(1) The low ratios of land use and productivity caused by impediments to agricultural production in the Study Area are considered to arise mainly from the following conditions:

- deficient drainage facilities
- river flooding
- deficient road network
- unimproved agricultural infrastructures

Further, there are problems such as many small-scale farmers, unsatisfactory agricultural financing, insufficient farming technology, decrease in agricultural income owing to unstable employment, which should be also taken into account for the stability both in regional communities and in the regional economy.

As a countermeasure, the execution of various proposed agricultural infrastructure projects and promotion of the agricultural production plan, settlement, rural planning and agricultural promotion plan will be requisite for regional development.

To develop agriculture in the Area and its neighbourhood, to increase employment, and to promote the welfare of the inhabitants, marketing, agriculture processing industry and development of agricultural facilities should be promoted, together with the implementation of the projects mentioned in the following article.

(2) The projects to be implemented over the whole area are to be ;

Drainage improvement: Principal drainage canal		
	New construction	124 km
	Rehabilitation	44 km
Secondary Drainage Canal		
	New construction	219 km
Flood Protection Project	: Enbankment River	118 km
Road Netwok Project	: New construction	82 km
	Rehabilitation	151 km
Settlement & Rural Development	: Public facilities in	
Planning	New settlement	3 places

(3) The estimated project cost is as follows:

Unit : US$1,000

Zone	Estimated project cost			Project cost per ha
	Total	Foreign Currency	Domestic Currency	US$ / ha
Whole zone	89,309	61,988	27,321	2,019
A	14,680	10.284	4,396	2,019
B	24,369	17,227	7,140	1,937
C	16,998	11,655	5,343	2,248
D	33,264	22,822	10,442	1,948

(4) The date of the project may be set at A.D. 2,000. Considering the scale of budgets and volume of projects, it will takes 12.5 years for the whole area and 4 years in the zone B.

(5) When the projects have completed as scheduled, at the target year, an annual benefit equivalent of US$54,012,000 is expected to an increase in agricultural products.

(6) From the expenditure and benefits relating to this project, the internal rate of return (IRR) for 50 years of the project life is as indicated in the following table.

Zone	IRR
A	21.7 %
B	25.4 %
C	22.8 %
D	20.5 %
Mean	22.6 %

These figures will prove economical viability other projects in Costa Rica.

7.2 Recommendations

(1) The implementation of this project will not only benefit the inhabitants in the area directly will also have a socio-economic impact on the country as well as the Area. We are, therefore, pleased to recommend that the Government of Costa Rica take measures for the implementation of this project based on the Master Plan.

(2) For the promotion of this project, it is required that drainage and road improvements are required in the early stages, and each zone must be ranked in order of priority and the project should be phased.

(3) Considering the social environment and economy, the following order of development in this project will be adequate.

First	Zone B
Second	Zone D
Third	Zone C
Fourth	Zone A

(4) For efficient implementation of this project, strengthening of the agricultural supporting organization is required, and the market and distribution systems must be improved in cooperation with each level of administration of the government. The following specific items can be mentioned.

- To manage and strengthen the agricultural supporting organization
- To increase and improve agricultural processing facilities
- To arrange market and distribution facilities
- To install an farm machinery center.

(5) Environmental protection for forest and virgin forests
In each area there exist woods and virgin forests. Especially in the low and moist area along the canals on the coast, virgin forests cover areas where some and rare animals live which are of importance as tourist resources. Therefore, the development should be restrained for the environmental protection.

The land use plan of this project has been set up in consideration of this background and these areas are exempt from exploitation. However, in carring out this project, further precautions should be taken for the environmental conservation.