3.9 Agro-Economy

3.9.1 Agriculture Labour Force

(1) Agricultural Labour Force

Estimation and projection of the population in the municipality of Olanchito and of Saba between 1980 and 1985 is given in Appendix, Table E-9.

According to it, the annual growth rate of the population including the inflow of imigrants under agrarian reform scheme in Olanchito municipality is set to 3.6 percent.

It is worth to note here that the number of families to migrate under the agrarian reform scheme in the whole country in three consecutive years from 1984 will be five hundred per year, according to the memorandum issued by INA in the end of July, 1984. Cost of migration to be spent by the government is 437.2 lempiras per family in 1984 price.

In the present situation, some of the family members have to find works either in the large scale farm or in the ranches or in the construction sites, besides their daily works within their family or co-operative's land. When intensity of agricultural production is increased with the introduction of irrigation water, the situation will change dramatically. There will be a scarcity of labour force at the peak time. In such cases, there will be a flow of labour force from the mono-culture zone, if the peaks are not overlapped with another one.

According to the information given by the INA's office in Sinaloa, more evacuees from the affected area of El Cajon hydro-electric power project will be expected to migrate to the Aguan Valley.

Then the negotiation is going on between the government of Honduras and the UN High Commission for Refugees on the matter where to make the refugees from Guatemala and El Salvador settle down. The area on the left bank of the Aguan, above the town of Coyoles may be designated as one of the camps.

In this way, there won't be any scarcity of programs for induced migration into the valley of Aguan.

A cursory demographic survey of the study area shows that the average size of the family is 5.7. The number of children whose age is above fifteen years differs according to the cooperatives due to the age of the parents. (See Table 3-14.)

Another social factor to be noted here is that women do not work in the field. So average member of the cooperatives of the study area can provide 50 work-days a month at the most. The head of the family and a son whose age is above 15 years old work 25 days a month each.

The quantitative analysis of the requirement of hired labour will be given in Chapter 4.

(2) Settlement

The study area neighbours on Olanchito township on its upper end and on Saba township on its lower end. Olanchito is the central town of the Olanchito municipality, the one of the twin towns, Coyoles-Olanchito, where the product of banana plantation and those of cattle and milk are gathered, and further transported to outside the valley by railway, by road or by air. Saba is the central town of the Saba municipality, and is located at the junction to La Ceiba and to Puerto Castilla.

Plantation of different crops are located side by side beyond this place downward, i.e., banana, citrus, and palm Africana.

In the study area, on the right bank, there are several settlements, between the Monga and the Jaguaca, among the settlements of the cooperatives, Monga, Tepusteca, Balsamo Oriental, Campo Nuevo, Armenia are bigger ones. Between the Jaguaca and the Mame, Maloa, San Francisco, Boca de Mame; and between the Mame and El Puente, Mendez, Jalisco, Bacatoma Barranco, La Sabana, San Carlos, Puerto Escondido and Potrerillos.

On the left bank, Carbajales, El Juncal, El Pimienta and El chaparral. Above the Jaguaca, many estates land are also found in the area along the cooperatives' land. According to SAGO's information, there are 56 ranches of different sizes on the right bank, between Olanchito and the Jaguaca, 31 on the left, between Olanchito and El Juncal.

In many occasions, the original settlements of the co-operative members are not located in their fields assigned to them. Some have to walk as far as 4 kilometers to reach their farm, or some have to cross the river by boat. (See Table 3-14.)

There has been a tendency that some of them have been building new farm houses in their field.

3.9.2 Management of the Co-operatives

This sketch shows the present state of economic life of the family of the farmers who belong to the co-operatives in the study area. This section is written at the end of September 1984, and the data relied mostly on the inquiries and observations made during the field study of the area in August 1984. The list is summarized in Table 3-14.

Though not all the land which belong to the co-operatives are cultivated by collective farm system, by and large, the destiny of the member families is influenced by the general directions set by the co-operative. So, we shall analyze the economic base of the life first and then bring up the question of the principle which rules the co-operative's economic activity.

The major basic grain cultivated in the study area is maize. In the Sector 5, each family grows it, collectively or privately, on the field of 3.14 manzanas (mzs) on average. And he gets average harvest of 42.7 quintares (qq) per manzana. Though not all the farmers have two crops of maize a year, most of them grow cassava and plantain for their own use, some grow paddy and frijol (beans), and some have milking cows, not to speak of various fruit-bearing trees which they grow in their backyards, and of chickens, ducks and pigs which are found not only in their kitchen gardens but also in the farmhouse, chirping and sneezing.

Besides ordinary tropical and semi-tropical fruits like papaya, mango, avocado, coconut and orange, plum and tamarind are also found. Many chickens die of New Castle Disease in the dry season.

So, on the whole, it would be reasonable to presume that the income from another crop of maize a year can safely represent the total income from all these minor products.

The price of maize is set to 13 lempiras, the medium of 10 and 16: 10 is the break-even point and 16 the guaranteed buying price set by IHMA on Sep. 15th, 1984 valid for a coming year.

The unit cost of input per manzana for the maize cultivation with partical mechanization and animal traction is 460 lempiras, in which 210 lempiras, the labour charge of 42 man-days is included. The cost also includes 5 percent tax.

Assumption is made that a family consists of 5.5 members, in which 1.5 members can be available for the works in and outside the field. So total income of family from the two crops of maize will be 1,916 lempiras.

Sale (family consumption is included.) :

13 Lps x 42.7 qq x 3.14 mzs x 2 = 3,486 Lps

Cost (family labour cost is excluded) :

(460 - 210) Lps x 3.14 mzs x 2 = 1,570 Lps

Income = 1,916 Lps

The cultivation of maize requires 264 man-days' labour.

(42 man-day x 3.14 mzs x 2 = 264 man-days)

As one family can provide 450 man-days per year, 186 man-days can still be utilized.

(25 man-days/month x 12 x 1.5 - 264 = 450 - 264 = 186)

If these one and a half men of the family can find 5 lempiras-a-day jobs for 4 months, 80 percent of available days outside their own co-operatives, the family can earn 750 lempiras.

5 Lps x 1.5 x 25 x 4 = 750 Lps.

The total income becomes 2,666 lempiras. With the family size of 5.5 members, per capita income will be 485 lempiras, which is equal to 242 US dollars in official exchange rate.

A family of full time agricultural labourers with the same family composition like the members of cooperative "San Francisco No. 2" can presumably earn 2,250 lempiras a year, per capita 409 lempiras, 205 US dollars.

(5 x 1.5 x 25 x 12 = 2,250 Lps.)

As is the case with the farmers in the Sector 5, farmers whose composition of income consists of 72 percent in farm income and of 28 percent in the salary acquired from outside the cooperative's field earn 18 percent more than the full-time agricultural labourers.

In the rest of the study area except coopeative "San Francisco No. 2", each family grows maize on 1.96 manzanas of land, with a good unit harvest of 47 quintares. A family earns 1,415 lempiras by maize production. The family uses 165 man-days for the production and has still 285 man-days in hand. If it can find jobs for 6 months, 80 percent of available man-days, the additional income will be 1,125 lempiras, which will bring a total income to 2,540 lempiras.

In the Sector 5, all the fifteen cooperatives have been cultivating a portion of land collectively, so far as the maize crop is concerned.

The ratio of land area where collective farm system is adopted to the total area cultivated is 29 percent. There is no cooperative which cultivates all its land by collective method.

In the rest of the area, the ratio goes up to 37 percent, though three cooperatives out of them are cultivating all their land privately, and one cultivates all the land collectively.

We put a question to all the presidents of the co-operatives of the study area with regard to the best method for the cultivation of their cooperatives' land. Their answers are shown below.

The Best Method of Cultivation of the Cooperatives' Land

Method	Collective	Mixed	Private	No answer	Total
Sector 5	3	11	1	0	15
Others	2	7	0	2	11

(The president of the cooperative which cultivates all its land collectively chooses "mixed method" as his answer.)

They think collective farming is, in principle, the best suited method for the co-operatives. One says, "If there is no collective farming method, there is no co-operatives", and "collective method capitalizes the co-operatives", says the other. But actually both co-opertives are adopting the mixed method.

Some have a pragmatic reason or two to give preference to collective method, beause the co-operatives need to have finance and mechanization.

When we follow this logic, if there is no finance, there is no necessity of forming a cooperative. So this is the general feeling prevailed in the co-operatives whose number of members is decreasing. Besides, leaders had to take the minds and behaviour patterns of the member farmers into account. Most of the farmers are not accustomed to collective farming in their original place of living. Furthermore, there is a question of identification. In most of the co-operative, members have come from different parts of the country, and group identity is yet to be established among them.

So a conciliatory step for the solution of the situation is the mixed method. The ratio between collective land and private land differs in each co-operatives. The study of the case with the USSR and the China may shed light on the matter.

The availability of the family labour is one of the key factors to decide the optimal combination of collective farming and individual one.

3.10 Agricultural Market

3.10.1 Introduction

Honduras is an agricultural country. It joined the group of grain importing countries in 1975 and, as ill luck would have it, has not been able to leave it since then. Yet, it has to live on agricultural products, so it has been exporting such cash crops as banana, coffee, sugar, tobacco, cotton, meat etc.

Honduras belongs to various regional inter-state political and economic organizations such as Organization of American States, Latino Americana de Integrelnation (ALDI) and Central American Common Market (CACM). It is also a member of such agro-commodity cartel as Group of Latin American and Caribean Sugar Exporting Countries, Bogota Group of Coffee Exporting Countries and Association of Banana Exporting Countries.

Table E-10 of Appendix shows the relationship of Central American countries with various interstate organizations, world-wide and regional.

3.10.2 International Market

Honduras is an agricultural country even within CACM comparing to Guatemala or to El Salvador. It still remains in CACM, notwithstanding its having experienced vicissitude. Its dependency on the CACM has been notably less comparing to other member countries. The tendency of the ratio between total external trade and that within the CACM zone is shown in Appendix Table E-11.

The contrast is remarkable. Table E-12 of Appendix shows that Honduras exports least, imports least and always stays as a deficit country in the zone. It seems as if it were regarded as a "A black sheep" among the CACM.

In 1978, as Table E-13 of Appendix shows, it relied less on CACM and Europe and more on USA than other CACM countries.

Table E-14 (i) of Appendix shows the recent trend of export of agricultural products. Except such primary products as timber, shrimp and lobster, silver, lead and zinc which also contribute to earn foreign currency, the list almost coincides with the list of export of principal products. Cotton fabrics, soap and canned fruits are three principal items of export of processed products.

All these cash crops are at the mercy of world market conditions. Nothing will be able to provide remedy for overcoming this destiny. If there are any at all, they are quality control of the product, effective and continuous marketing effort.

Domestic structure of production of each crops has been raising some problems. When some of the each crops like bananas are produced by big companies, they have their own strategies to maintain the quality of their product and the market, so far so good, but sometimes national interest and that of company do not accord. When some of the cash crops like coffee are produced by small producers, the administration has to do something for its quality control and marketing. Administration should have a consistent policy to bring all the aspects of production structure under control.

Table E-14 (ii) of Appendix gives the figures of imports of agro-inputs. Fertilizer and chemicals are included in the first category and the tractors in the second.

Following is the commodity-wise description of world market with special reference to the Honduran production. Honduras joins three commodity cartels, coffee, banana and sugar. As the cartels dictate the concerted action to the members, there won't be much to say about the trade increase of these commodities, but to say that the country should continue or initiate the effort in the betterment of quality and in establishment of honduran brand.

So, citrus, meat, pineapple, palm oil and cacao are dealt here. Cotton and tobacco are not included in the list, as they are not among

the crops in the study area. Considering the fact that African palm and citrus were selected as cash crops for export in the Lower Aguan Project; palm oil is dealt first, though it has just made a debut in the export market scene from Honduras, and the citrus the second.

(1) Palm Oil

Table E-15 of Appendix helps reader look at the picture of world production and trade of palm oil in perspective. In 1982, total production was nearly 6.4 million tons. Since 1973, production has been increased at the annual rate of about 10.5 percent, i.e., 2.5 times in ten years. Top three producers were Malaysia, Indonesia and Nigeria in that year, and for some time in future this sequence will continue. These three countries produced about 81 percent of the world production of palm oil. Honduras's share of production was 0.2 percent.

The performance of the export of palm oil is a little different from its production, market share of Malaysia was almost 71 percent in 1981.

In the second place appeared Singapore with 13.2 percent and Indonesia comes the third with 6.1 percent, then the Netherlands with 3.3 percent share. Nigeria turned into an importer with a share of 1.9 percent.

Both Singapore and the Netherlands were doing improvement trade. The latter also imports crude from Malaysia.

The crude oil COPALMA has just started to export to the Netherlands are refined there and resold to other European countries. So without having their own refinery in COPALMA, the directions of export will be limited. On the other hand, in Malaysia 90 percent of the product was refined, and their concern now is a slack capacity of the refinery facilities.

Import share of total OECD countries was 34.9 percent in 1981. U.S.A. was not a big buyer of palm oil. It's share was only 3.6 percent, and prices were relatively low comparing those in Europe.

International market structure of palm oil is given in Appendix Fig. E-1.

Among exporting countries, Singapore and some countries of EEC and EFTA are doing processing trade. A glance of the figure and consideration of present production structure of Honduras teach us that the strategy for the time being will be considered to sell the refined product to USA and around the country and sell the crude to Europe as an intermediate commodity.

The price and market size of the palm oil has been developed by its own merit, but still cannot escape from the influence of the same of other variety of oil.

Table E-16 of Appendix shows the share of palm oil production and of export.

It tells us that the share of palm oil production in the total vegetable oil production (soft oil and non-soft oil included) has been gradually increasing and it reached 15.7 percent in 1980. The share of export was 23.5 percent in 1982. Table E-17 of Appendix shows the market size of major vegetable oil in 1981.

As the total consumption of vegetable oil and animal oil is proportional to the total population, the increase of one type of oil more than population growth rate is the decrease of the other. The decrease occurs due to natural or human made disaster such as draught, plant desease or war. For example, Malaysia's increase of palm oil export coincided with the decrease of production and high price of coconut oil produced in the Philippines. India has also started buying it as a relatively cheaper substitute of animal oil. So, if the price goes up, India will surely find some other substitutes, meanwhile she has started planting palm. Malaysia has been trying to develop a new market with success and to put money on R & D effort. R & D tax on the crude oil is 4 Malaysian dollar per ton. Of course, the biggest competitor of palm oil is soy bean oil from Brasil and USA.

Incidentally, U.S.A. is a big buyer of coconuts oil. In 1981, its share of import was 29 percent, and Honduras itself is also a buyer of various oils, above all, cotton seed and soya.

In short, export of different kinds of vegetable oil are complicated affairs, the strategy of export of palm oil should be built up in the context of total vegetable oil production, export and import. Aspect of production is not dealt here but a mention or two of its major attractions, desease resistancy and productivity.

(2) Citrus

The habitat of the citrus is the warmer part of the temperate zone, but it is now found almost everywhere in the tropical as well as in the temperate zone. With its peaceful expansion, the original sanscrit name of "Narange" goes with it. The modern irrigation system has helped the expansion of cultivated area. The wider its cultivated area becomes, more the number of varieties becomes. "Satsuma" local variety of "Unshu" orange which grows in the southern tip of Kyushu islands of Japan, for example, is found its market in the French Market of New Orleans. (Incidentally two hundred years ago, "Satsuma" was known as inexpensive ceramic bottle for keeping condiments and wine at Batavia port (Jakarta) of East Indian Company of the Netherlands.

Tables E-18, 19 and 20 of Appendix give the perspective of production, and trade of the orange, lemon and lime and grapefruit. In 1982, about 53 million tonnes of citrus were produced in the world: Oranges about 80 percent, Lemons and grapefruit about 10 percent each. In 1981, about 13 percent of

the total production was exported. This shows there can be a nook or two in any market for every exotic variety of citrus along with standard varieties of citrus.

The characteristics of the world citrus market is that the share of export of OECD countries is about 60 percent, and import 70 percent. Above all, USA is the biggest producer of all the three varieties of citrus and a leading exporter. Still its share of import is 0.5 percent.

Saudi Arabia, whose share of import is 4.4 percent in 1981 and its share of export is 0.3 percent in the same year has several suppliers of North African countries. It is desired that Honduras will find its way in to the small segmented markets of Europe or USA.

The market strategy should be based on the diversification of production of varieties to cope with the smallness of the market size of each varieties according to the consumers' propensities.

All the components of the quality of segments of flesh such as colour, sweetness, sourness, texture and even the existence of pip or not have to be considered. Peel cannot escape from attention either. Ordinary customers think the colour of peel is yellow. New Japanese Lemon lost the market in its own country against established Californian Lemon represented chiefly by Sunkist because its peel is thicker than Californian.

More or less, citrus is found in the markets of OECD countries all the year round. It comes from suppliers of nothern hemisphere and of southern hemisphere. But there surely is between season of the big suppliers and that is the only chance that Honduran product can penetrate into the market.

Citrus juice concentrate is the last resort of surplus production, as the juice of different varieties can be blended in certain extent if they are within the same group of the three basic varieties: orange, lemon and grapefruit. Of course, the concentrate has its own distinctive market. By blending, juice of the ideal taste to the specific market can be created. A citrus growers cooperative of Ehime prefecture of Japan has succeeded in selling the orange juice of its own brand "POM" to the Middle East countries.

The taste is different from the juice it sells in Japan. It has conducted an intensive market research in Saudi Arabia and adjacent Persian gulf countries to get to know the propensity for the orange juice of the people who live there before it prescribed the ideal blending formula.

(3) Pineapple

Table E-21 of Appendix gives various aspects of international trade of pineapple.

In 1982, production has increased 1.7 times since 1969. USA is a producer with its share of 7 percent in 1981 and 1982 (including Puerto Rico), but she is at the same time the biggest importer with the share of 23.4 percent. The second biggest is Japan with 11.6 percent. Calculated in value, about 90 percent of the export, both fresh and canned fruits, goes to OECD countries. Americans like to eat canned fruits. She imported canned fruits 12 times as much as the fresh one in value. In general, people in OECD countries have same tendency (2.5 times) except Japan, which imported fresh fruits 3 times as much as canned fruits in value. Mexican pineapple along with mango reaches Japanese market.

The safest arena to compete with other producers is USA. In items of barter, one can include apples besides industrial products. They are exporters of apple.

Middle East Region is another area of interest. But, they are geographically nearer to major exporters.

(4) Cacao

Like coffee, international producers cartel or cocoa beans has been formed. It has been tying to rescue the producers from the vicissitudes of the world market by having buffer stock of the commodity.

Main producers are concentrated in the west Africa. Ivory Coast is the leading producer and exporter. It produces and exports about a quarter of the total amount of world production and export. Ghana comes to the second. Nigeria and Cameroon were the fourth and the fifth in 1982 as Brizil stayed in the third. Bush fire in Ivory Coast and Ghana destroyed the crop and gave damage to the trees in 1982, but the plants healed from the burn faster than expected and the level of production returns to the pre-fire days. So the producers cartel continues to play its role to stabilize the world market price.

The shares of production and export from the countries in the Latin America except Brazil to that of the world were 15.4 percent and 7.0 percent respectively in 1982. Among them Ecuador and Dominican Republic were the leading exporters, whose share were 3.3 and 2.7 percent respectively. In same year OECD countries imported 77.1 percent of the total world import. The Netherlands, the West Germany and the USA are the three leading consumers, whose share of import to that of the world are around 15 percent each. Table E-22' in the appendix gives the trends of the world market prices in recent years.

(5) Beef (Including Buffalow Meat)

Table E-22 of Appendix gives the various aspects of production and international trade of beef.

Production had increased about 20 percent in ten years (1982). The most peculiar phenomenon in the world beef production is that India, where the largest number of cattle live*, produces very little meat. The second peculiar thing is that USA, the biggest

producer of meat, and USSR, the second, are respectively the second and the fourth biggest importers of meat. The share of export of OECD countries is 78 percent and that of import is 70 percent. The third peculiar pehnomenon with the trade of meat is that some of the countries export meat and import it at the same time, like France, West Germany and Great Britain. European COMECON countries also export meat and import one.

With all these strange phenomena, a solace or two for Honduran exporters is that USA is a big buyer and some neighbouring countries continue buying it from Honduras.

OECD countries are big exporters of pork and mutton (87.4 percent and 90.2 prcent each), and of milk, butter and cheese (98.1 percent, 94.9 and 95.3 percent each), so there is little room to establish an overall export strategy of animal husbandry. So status quo is maintained in the export market and try to improve domestic market, if we consider the fact that Honduras is consuming less meat than other CACM countries and importing a lot of milk powder.

*18.1 percent of cattle live in India in 1982, 8.6 percent each lived in USSR and USA in the same year.

(6) Small Potential Market in U.S.A.

If we limit our consideration to the export of future products of the study area, there are a few potential markets of suitable size almost the southern coast of U.S.A. i.e., residents of Latin American origins in New Orleans, Houston and Miami.

Honduran community in New Orleans exceeds 30 thousands : refugees from Cuba and Nicaragua in Miami. Beans, plantain, cassava, avocado and mango are some of the agro-products they are keen to take.

With the opening of Puerto Castilla, products are not necessarily carried to as far as Puerto Cortes or La Ceiba. This will increase the competitive edge of the products from the Valley to those from other areas of Honduras. Naturally, CACM countries, Mexico, and some Caribbean countries are producers of all these products.

3.10.3 Domestic Market

An overall aspects of supplies of grains is shown in Appendix, Table E-23. Table E-24 of Appendix gives the idea of the scale of import of foodstuffs.

Here domestic agricultural market is dealt in the context of import substitution and the development of the processing industries. Honduras has been importing grains; wheat, maize, and rice. Beans and sorgums are self-sufficient. She imports milk and edible oil, too. Among grains, wheat has to be imported, as there is no suitable surplus areas to grow it. She is importing it from the USA at generous terms provided by PL 480.

Maize production, on the contrary, ought to be increased up to the level of self-sufficiency because the country has the potencial to do so. Though the amount of rice imported is one digit less than those of maize in tonnage, it ought not to be imported, either.

If people have started showing a liking for rice more than before, then this increase would be satisfied by the domestic increase of production. In the study area, many farmers grow upland rice at their own risk. So far, they would be satisfied if they got one successful crop even after two consecutive failures.

Milk is another product which ought not to be imported. Pastures are found virtually everywhere in the country, beef is exported, and cheese has amassed in a storage in Olanchito. This clearly shows a lack of processing and transport facilities.

Import of edible oil shows a little bit complicated picture than the rest. Edible oil imported consists mostly of cotton seed oil and soya bean oil.

Honduras imported palm oil in 1980 and 81 in sizable amount. It won't occur in future with the increase of palm oil production.

Cotton seed will also increase with the increase of production of cotton. To a certain extent, palm oil may be a substitute of soya bean oil. Thus import of oil can be reduced. (See Appendix, Table E-25 (i).)

Self-sufficiency of food is not necessarily a barometer of stability of a national economy. Policy of self-sufficiency of some of the foodstuff can often be abandoned to encourage other sector's activiies. But when agricultural country with the balance of payments deficit is not producing enough food for her own people, then the national economy is serious ill.

Agro-processing adds value to the original product. Table E-25 (ii) shows Honduran export of processing agro-products. Even confined to the edible processed products, the degree of processing varies : drying of grains to concentration or dehydration of fruits, vegetables or milk : cannery or bottling to refinery or distillery. One of the main objectives of agro-processing is preservation of agro-products. Preservation also implies market creating effects. Perishable seasonal crops like fruits and vegetables can be available all the year round in different forms. Processing like concerntrating regulates surplus production. Dehydration like powdered milk overcomes a transport bottleneck. Agro-products, boiled or cooked or mixed and then canned have broadened the consumers' choice. Foreign markets are open to the processed goods, too.

As a strategy to go into a domestic market small processing units would, thus, be useful for the enterprises run by cooperatives in and around the study area in future.

In this case, care should be taken to maintain the quality and hygienic standard of the products. By doing so, the co-operatives of the area could control the seasonal surplus of the product easier and gain ground in the price negotiation with the bigger processing factories.

3.10.4 Local Market

The market survey was conducted in Olanchito, Coyoles Central and Saba. Enquiries about local wholesale market situation were also made at every cooperatives in the study area. Figures are shown in Appendix, Table E-26. As a reference, wholesale and retail prices of footstuffs at different major towns in Honduras are given in Appendix, Table E-27.

In general, access to the market for the cooperatives is limited. At the crucial moment of harvest, markets are virtually closed to the farmers. Without dryers and without storages, farmers are at the mercy of the hands of market manipulators.

When they want to sell their crop in season, the market abounds in the same crop; when they have to buy some other basic grains which they do not grow or even maize out of season, the price is prohibitively costly, that some farmers suggest the need of establishing consumers' cooperatives among them.

(1) Basic Grains

The IHMA does not buy maize much, especially in springtime, by financial and some technical reasons, though it ofered 16 lempiras per quintal at the time of the study. So most of the farmers go to Coyoles Central, where farmers sometimes can only realize 7 lempiras per quintal, less than half of the price IHMA quotes. So farmers make faces, saying Coyoles is a "coyote" for them.

Rice and wheat flour are found all the year round. In the study area, farmers try to grow rice whenever the low wet land is available, which is more vulnerable to flood. They themselves like to take rice, so they buy rice if they can afford to.

Bean is an only basic grain which is not found in market during the dry season.

(2) Cassava, Plantain and Potato

Farmers grow cassava mainly for their own use, the rest goes to market. So the price here is as high as that in La Ceiba. Whereas, farmers in the study area know that the plantain has good marketability. Small scale commercial plots of plantain are found in the area. People in the valley seem to have a liking for it. Most of the potatoes are coming from La Esperanza. So it is costlier here than in La Ceiba.

(3) Vegetable and Fruits

Most of the vegetables come all the way from San Pedro Sula, even tomatoes, cucumber and chilli. Farmers grow these vegetables, only for their own use. One cooperative grows tomatoes for commercial purposes, but it has not been successful in selling them to the local market. So it has been selling them privately and directly to individual consumers.

Bananas are free of charge, if you take a trouble to go to the plantation and bring back a bunch or two which has not made the grade.

Oranges are not found in the market. Street venders sell them by peeling or squashing them. Pineapples are sold in the market.

Other fruits are grown in each farmer's kitchen garden for family consumption.

(4) Meat, Milk and Egg product

Thanks to COSUDE's effort, beef, pork and chicken are founded in the cold storage in Olanchito.

Cheese and butter are also sold. Fresh cheese has overflown a small size local market into the cold storage, which is about to be bursting with 50 tonnages of them.

Fresh milk is sold at the door of agents' or breeders' town houses every morning. Eggs are from San Pedro Sula. but chicken and eggs from the local farmers are also coming to the market.

(5) Future Prospects

The development of the middle Aguan is a key factor to consolidate the regional economy of the whole Aguan valley, i.e., uppper middle and lower.

A projection of population growth rate in Aguan Valley between 1980 and 1985 is set to 3.86 percent by INA in 1983. If this trend continues, population of the valley will double in 19 years.

At present, some of basic grains and most of the vegetables come from outside the area, because economy of the upper and lower Aguan depends on the monocultureal agriculture, namely, banana, oil palm and orgnge. On the other hand, as an outlet of the regional production to the world market, Puerto Castilla has just opened.

With so much of opportunity, only some incentive in the form of capital is required for the balanced agricultural development.

3.11 Agricultural Infrastructure

3.11.1 Farmland and In-farm Road Network

The farmland in the study area extends for the most part along the right bank of the Aguan River, while there is no arable land along the left bank except for some along the Uchapa and the Uyuca Rivers.

The land use of upper and lower areas of the Jaguaca River is obviously different. Most of the upper area is used for the extensive grazing and a small area is used for plantation and shifting cultivation along the Aguan River. The road network in this area is rather poor. The main road between Saba and Olanchito and the railway of FNH are mainly used for the transportation of local people and agricultural products. Especially on the terrace along the Aguan River, most of the terrace is covered by pasture land, because of poor rainfall, though some maize cultivation during the rainy season can be seen. All the villages are located on this terrace except Jolisco which is located on the right bank at the confluence of the Mame and the Aguan rivers. These villages are connected with the above road network consisting of the main road and the other existing secondary roads.

The lower area from the Jaguace River is national land and is being developed under the cooperative system controlled by the agrarian reform of INA. However, a little area is cultivated along in-farm roads, and most of the area remains uncultivated because of a wide interval (2-3 km) of in-farm roads, lack of lateral road and poor drainability. Taking into consideration these constraints, therefore, the development of this area is judged to be desirable.

As for the left bank area, there is no arable land and most of the area is used for grazing. Further, although one railway and some existing roads which run along the Aguan are able to be considered as major transportation facilities, the condition of these existing facilities are not sufficient due to many crosses of small tributaries and irregular road surface. It is, therefore, proposed to put the first priority on the renovation and improvement of these facilities in order to facilitate domestic transportation.

3.11.2 Irrigation and Drainage

Years ago an irrigation system for the banana plantation was constructed on the right side of the Aguan River of the study area. The diversion works of that system were on the Aguan River, south of Olanchito (Above Pte. Olanchito), and some parts of the main canal, division works and aqueducts were facilities of concrete construction. However, about 30 years ago, because of disease, the banana plantation was evacuated from the study area. After that these facilities have never been utilized and now only the traces of them are shown in the study area. Therefore, it is not possible to repair and utilize those old facilities.

Presently, the river and ground water have been utilized only for domestic-use and there are no facilities of irrigation systematically used in the study area. Cropping has depended upon the weather and has been limited in area. Therefore the establishment of an irrigation system in the study area will produce a good effect on the stability of the cropping product.

Considering the drainage system in the Project Area, there are no artificial facilities except for the cross culvert of roads. At the present, it depends on gravitational drainages utilizing existing rivulets. A gentle inclination exists in the whole study area and in general the drainage is good. However, there are uneven lands and regular flooding in some areas. Also root rotting of maize was partially observed between the Jaquaca River and the Monga River which is caused by poor drainage as well as by a soil conditions, therefore a drainage system which is systematically connected to the Aguan River and tributaries will be required in the Project Area.

3.12 Transport and Social Infrastructures

3.12.1 Transport Infrastructure

(1) Road

One trunk road with a sub-base finish (gravel) links Olanchito with Saba. This road, comprising total length of 42.7 km, was constructed from January, 1978 through October, 1982 as a part of the 2nd stage of the Lower Aguan Project conducted by INA. The construction of this work was financed by BID and total amount reached 15 million Lempiras, 167% over its original contract sum.

At Saba, this road joins with the main access road to La Ceiba and the main road running the length of the Lower Aguan Valley to Puerto Castilla and Trujillo. As shown in Fig. 3-13, most of these main roads are constructed in sub-base surface except Corocito -Puerto Castilla and Trujillo where pavement finish is presented.

A new road linking La Union, Department of Olanchito with the Olanchito-Saba main road (at Mame Bridge) is under construction. The completion of this new road with a total length of 80 km is expected in 1986.

According to an official of SECOPT, the feasibility study for the pavement of the main road from La Ceiba to Olanchito via Saba (130 km) is being carried out now.

(2) Railroad

In the study area, along the left bank of the Aguan River, a railroad passes to link this area with Coyoles Central and La Ceiba. The total length of the railroad between Coyoles Central and La Ceiba is 125 km (if branch lines are included this length extends to 164 km).

Though this railroad belongs to FNH, its operation is entrusted exclusively to the Standard Fruit Company in view of its main cargo being banana production produced in their plantations at Coyoles Central. This railroad is also utilized to transport other agricultural and livestock products in the Aguan Region. Passengers do not constitute an important role for this railroad, though not a few people of the region make use of it.

The train stops at each station for about 15 minutes up to one and half hour to load and unload cargoes. It takes approximately eleven hours from Coyoles Central to La Ceiba. A passenger pays 5 lempiras, if he rides all the way. Payment of cargo per km/lb is approximately 2 centavos. One operation of the train is carried out daily from Coyoles Central to La Ceiba and vice versa.

The FNH in their report of the feasibility study recommended the extension of the railroad network in the Aguan Region to connect the existing network at Sonaguera with Puerto Castilla. The report foresees that export oriented agricultural products such as banana, palm oil, citrus fruits and wood to be produced in the region will be transported to Puerto Castilla via the new railroad network.

(3) Port

The port terminal which will have the most influence on the study area is found at Puerto Castilla located about 100 km from Saba and 140 km from Olanchito. This terminal newly inaugurated in July, 1984, was constructed by a local contractors' consortium with the additional cost of 25 million lempiras. Originally, an international consortium started the work with a fund of 38.8 million lempiras financed by the World Bank, but they suspended the construction work in 1980 due to the dispute on contract matters. This suspension had continued up to 1982, when the work was resumed by the above-mentioned local consortium.

The facilities which the terminal of Puerto Castilla comprises are: 150 m wharf, two warehouses with storage capacity of 5 million feet of wood, an oil storage tank with capacity of 5 million gallons, an office building and other auxiliary facilities.

With the completion of its modern facilities, Puerto Castilla is expected to be the principal port for the exportation of the wood of CORFINO, bananas of the Standard Fruits Company and palm oil and citrus fruit from the Aguan Valley.

(4) Airport

At Coyoles Central, near the banana plantation field of the Standard Fruits Company, there is one airport without paved runway where a commercial aircraft of LANSA lands three times weekly en route between Tegucigalpa and La Ceiba and Trujillo. The flight time by DC3 between Coyoles Central and Tegucigalpa and La Ceiba is about 50 minutes and 20 minutes, respectively. There are airfield in Olanchito and in Saba, but they are used very often for Cessna type small airplanes.

3.12.2 Social Infrastructure

It has been reported that desertion is a common phenomenon among the cooperative members of the Lower Aguan Project. According to the survey carried out by INA in cooperation with UNDP in 1980, the rate of desertion for 18 cooperatives of the Lower Aguan Valley had reached to 28.4% only between 1979 and 1980 (See Table 3-15). The survey indicated that one explanation of the phenomenon of desertion in the area could be the lack of adequate social services. The improvement of socio-economical situation is an important factor for the farmers settlement program of INA.

(1) Health

From national to rural level, the categories of health services in this country are as follows.

Level VI : National Hospital (6)

Level V : Regional Hospital (6)

Level IV : Hospital of Area (6)

Level III : Health Central with Doctor (CESAMO) (97)

Level II : Rural Health Center (CESAR) (457)

Level I : Services rendered by voluntary agents

* Figure in parentheses means number of hospital and health center.

There is one Hospital of Area in Tocao in the Aguan Valley; two CESAMOSs are found in Olanchito and Saba and one CESAR in Tepusteca, Sector 5, between Saba and the Jaguaca River.

In the urban area of Olanchito, in addition to CESAMO, 6 private medical and 4 private dental clinics are examining patients coming from the study area. Furthermore, a hospital with a capacity of 75 beds and 12 - 14 doctors is under construction in the center of Olanchito, though it has been suspended for three years due to the lack of financial resources.

The CESMO in Olanchito and Saba were visited to have acquaintance with the health situation of the area. According to the information obtained from direct interviews with doctors of CESAMO, the prevailing diseases of the area are: Malaria, Diarrhe, helminthiasis, Respiratory Decease and Undernourishment. It is said about 40% of rural population is infected by helminthiasis.

The problems with which people in the study area are confronted can be summed up in the following manner:

1. Sanitary facilities such as water supply and sewerage disposal system are not adequate.

2. Medical services both human and physical resources are insufficient.

3. Access to the nearest medical and/or health center is lacking; patients of rural area could not be attended on account of no availability of transportation.

4. Extension services by the public institutions in respect to sanitary and health education have not been carried out in efficient manners.

The features of two CESMOs (Olanchito and Saba) and one CESAR (Tepusteca) are illustrated in Table 3-16.

(2) Education

Table 3-17 shows the general indices of primary school under the administrative territory of Olanchito. On the secondary level there are four schools in the urban area of Olanchito; three of them are commercial schools and the other offers a bachelor program.

The survey at the supervisory office for primary school in Olanchito indicates the percentage of pupils in school age who attend the primary school is 88.9% in urban area and 83.3% in rural area, respectively. The reason for scholastic absence are pointed out as follows:

1. Increase of scholastic population in the settlement area of agrarian reform and, as a result, lack of school buildings and classrooms.

2. Deficiency of economical resources of the family.

3. Working for the family.

All of the primary schools in the urban area are equipped with 6 grades, but 27% of them in the rural area do not offer all grades.

In the Sector 5 where cooperative members are settled, there are two primary schools at Tepusteca and Balsamo Central. The primary school at Tepusteca includes 121 pupils and four teachers (one of them is without title). The school has a two schedule system, one in the morning (7:30 - 11:15) and the other in the afternoon (13:00 - 15:15).

Only two classrooms are available for 6 grades of pupils and pupils receive lessons in the same classroom jointly from 1st to 6th grade. The variety of age for each grade is a characteristic phenomena in this school (see Table 3-18). The number of pupils decreases as the grade goes up, because some pupils leave school in order to work for the family. Very few pupils go to secondary schools in Saba and/or Olanchito.

The low level of the educational system has been identified as one of the factors that have been prevented the development of rural areas in the country.

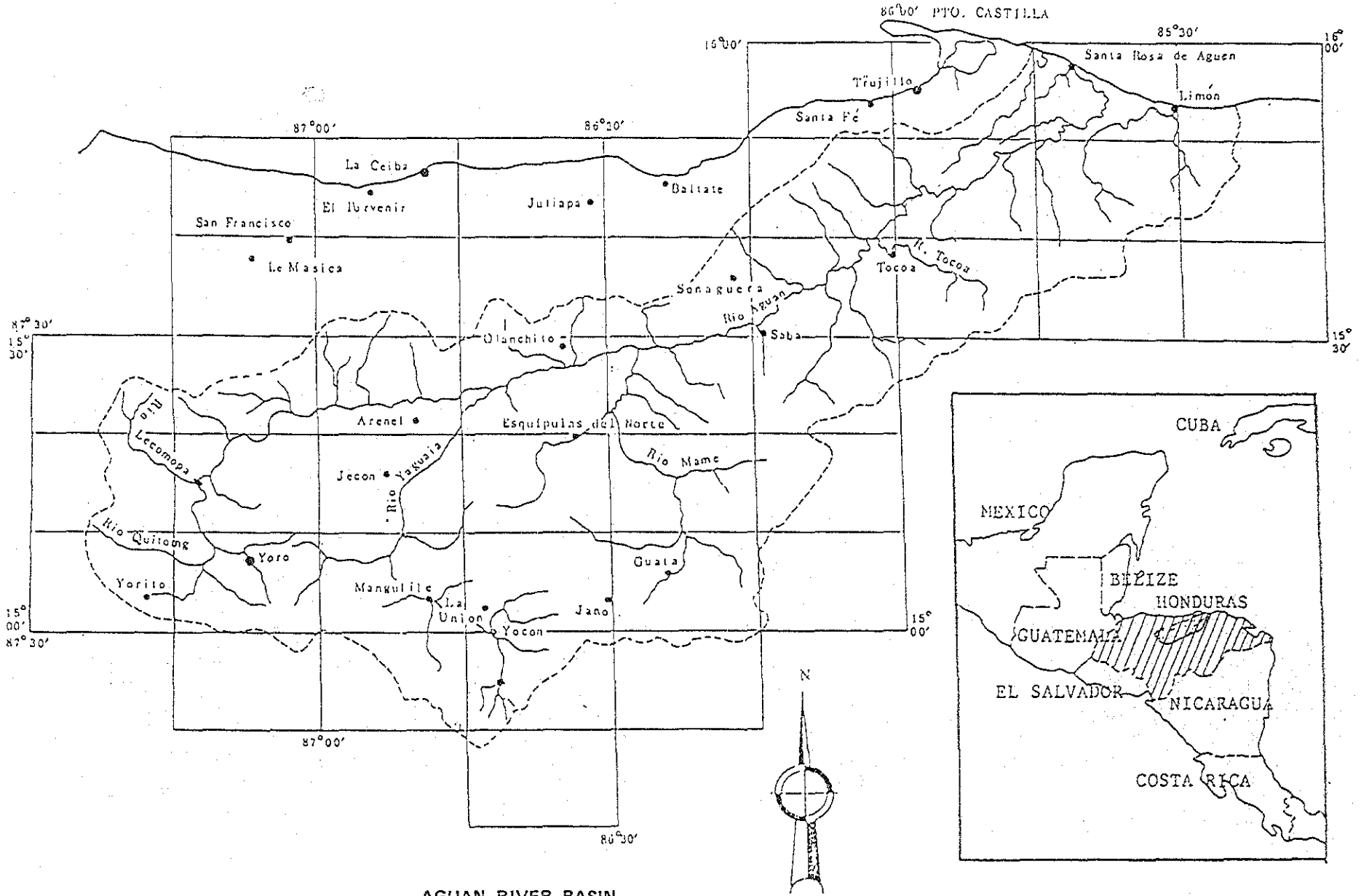


Fig. 3–1 AGUAN RIVER BASIN
CUENCA DEL RIO AGUAN

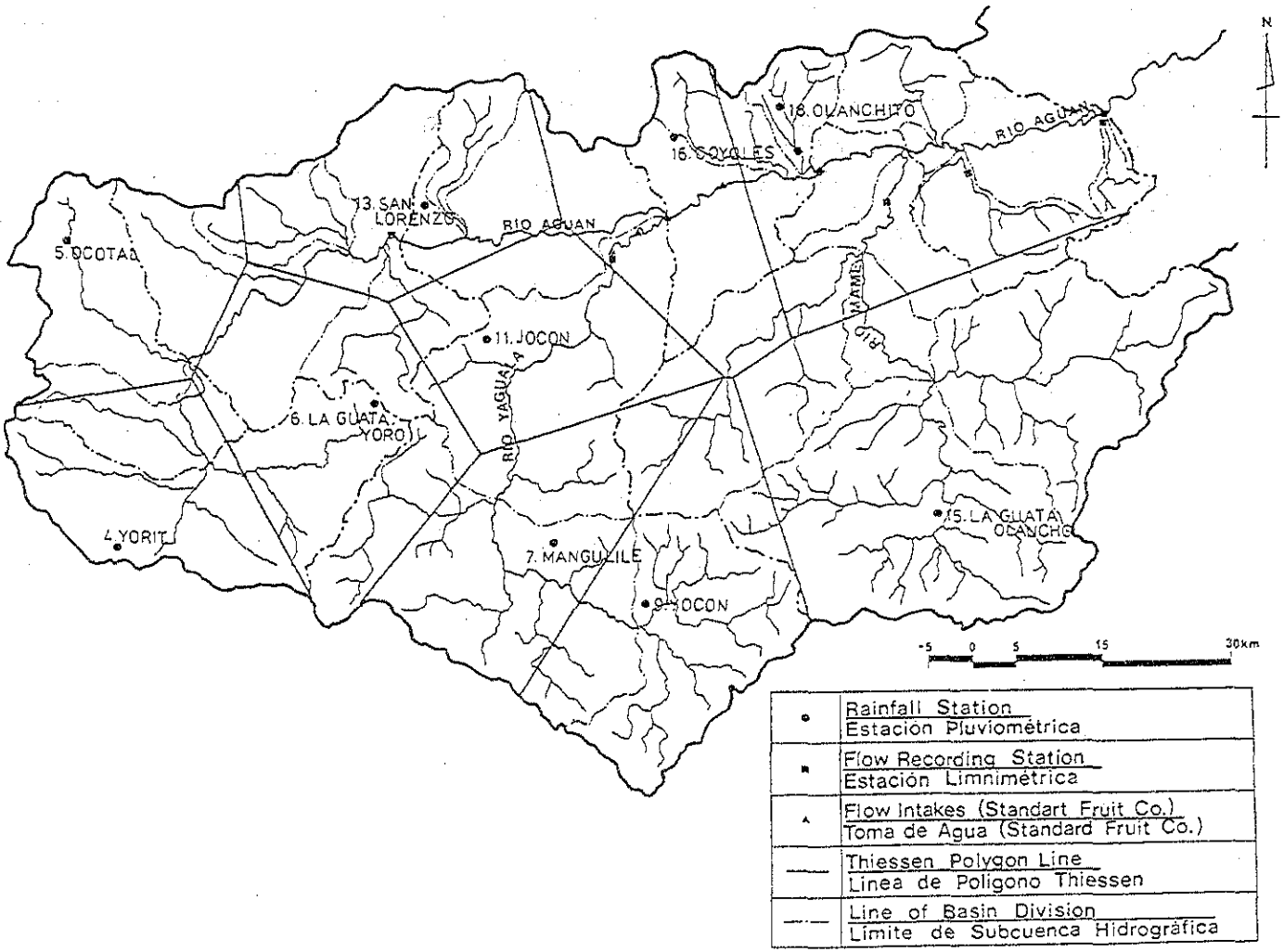
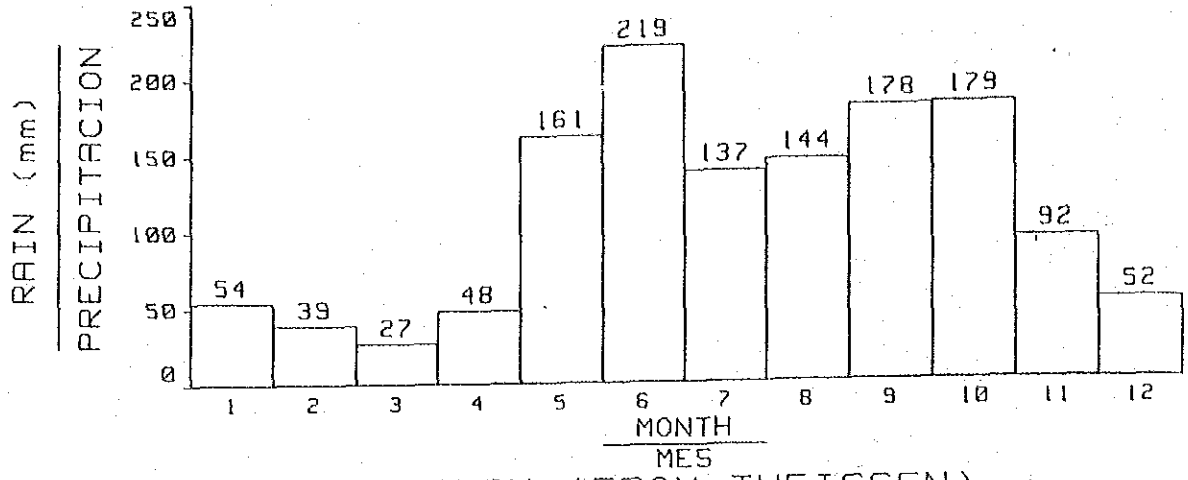
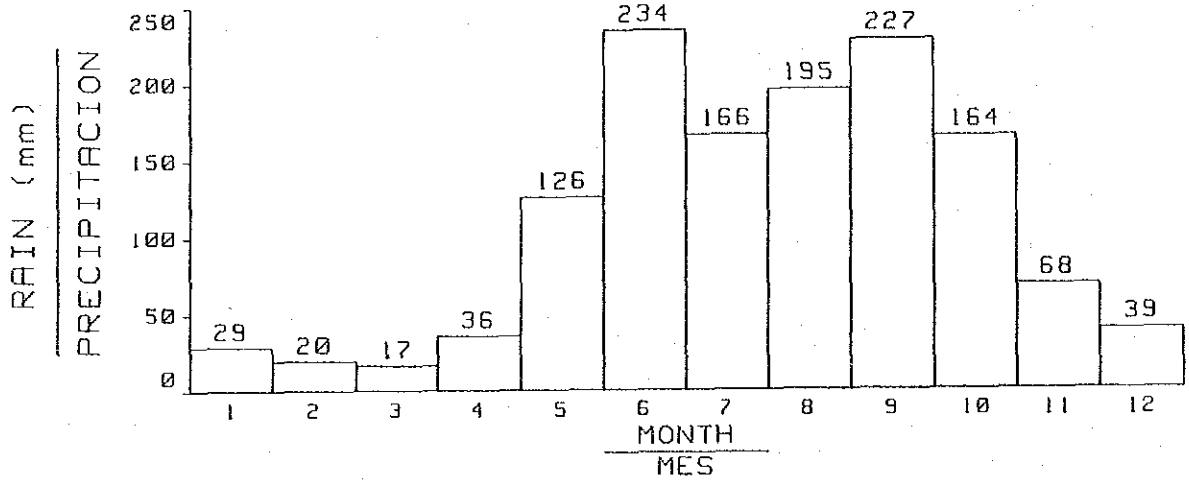


Fig. 3–2 THE ENTIRE CATCHMENT BASIN OF THE AGUAN RIVER AT PTE SABA
LA CUENCA ETERNA DEL RIO AGUAN EN EL PTE SABA





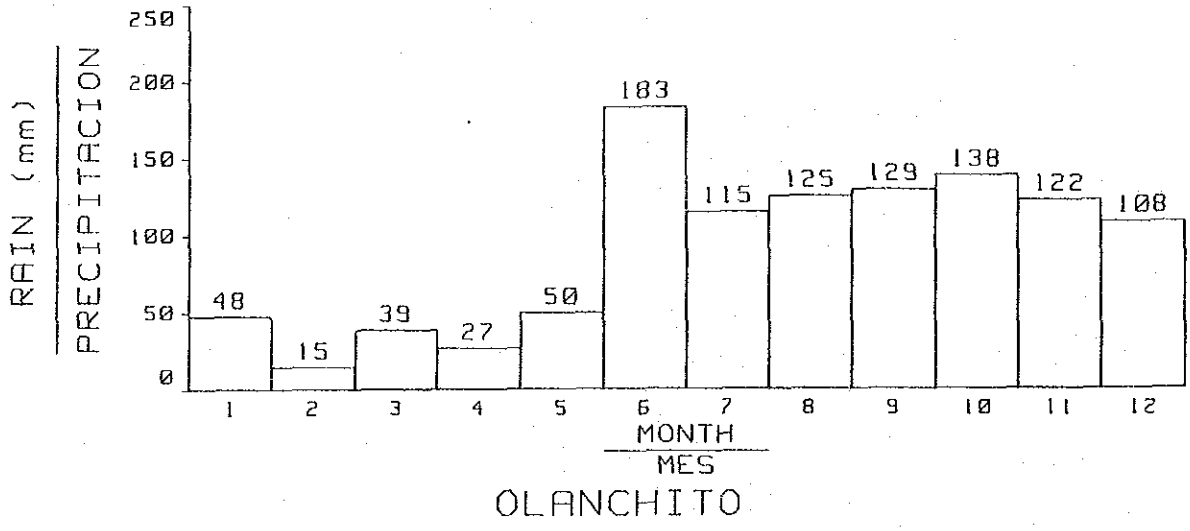


Fig. 3–3 MEAN MONTHLY RAINFALL THE FOR UPPER AGUAN (1973–1983)
PRECIPITACION PROMEDIO MENSUAL DEL RIO AGUAN

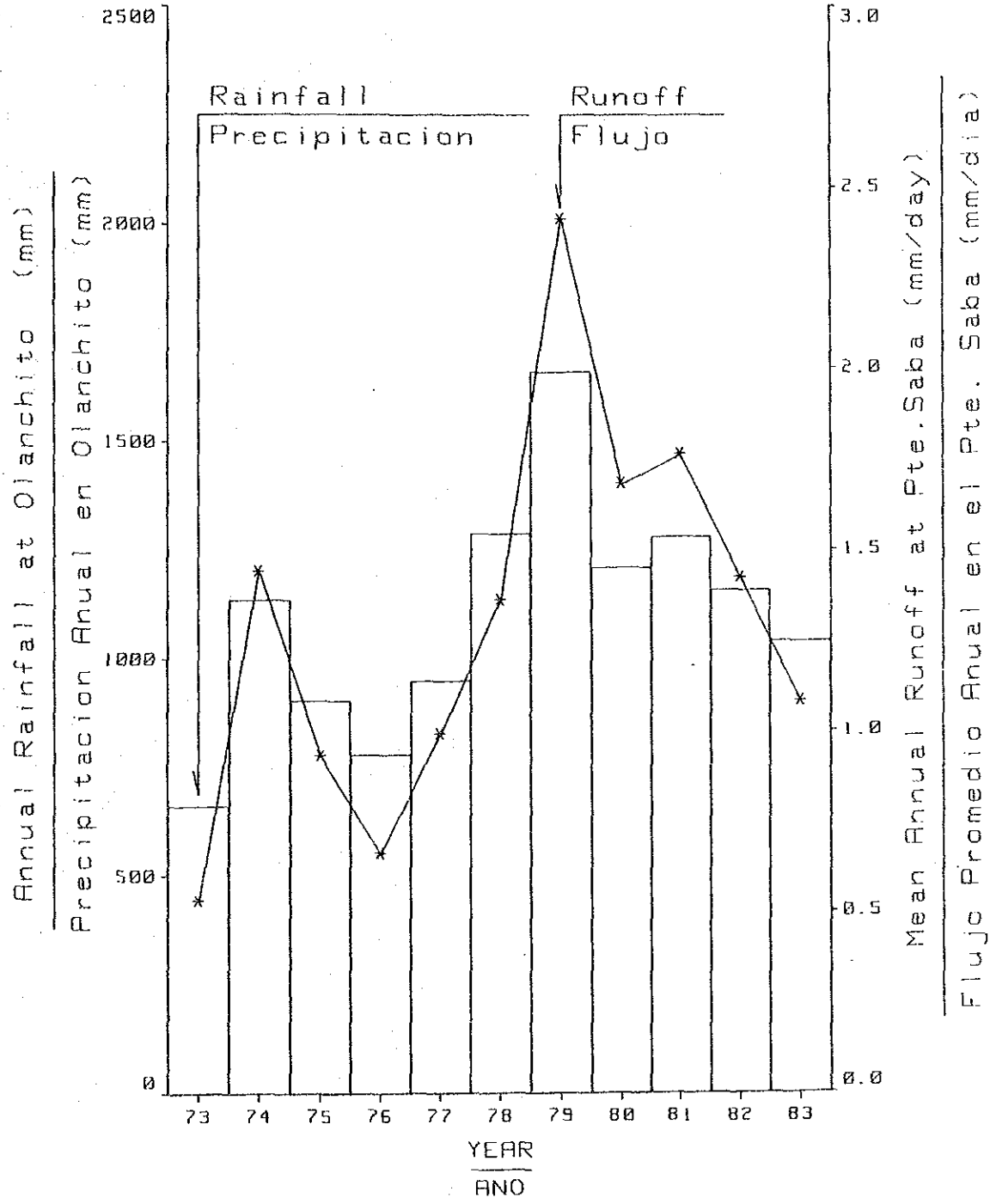


Fig. 3–4 ANNUAL RAINFALL AND RUNOFF
PRECIPITACION ANUAL Y FLUJO

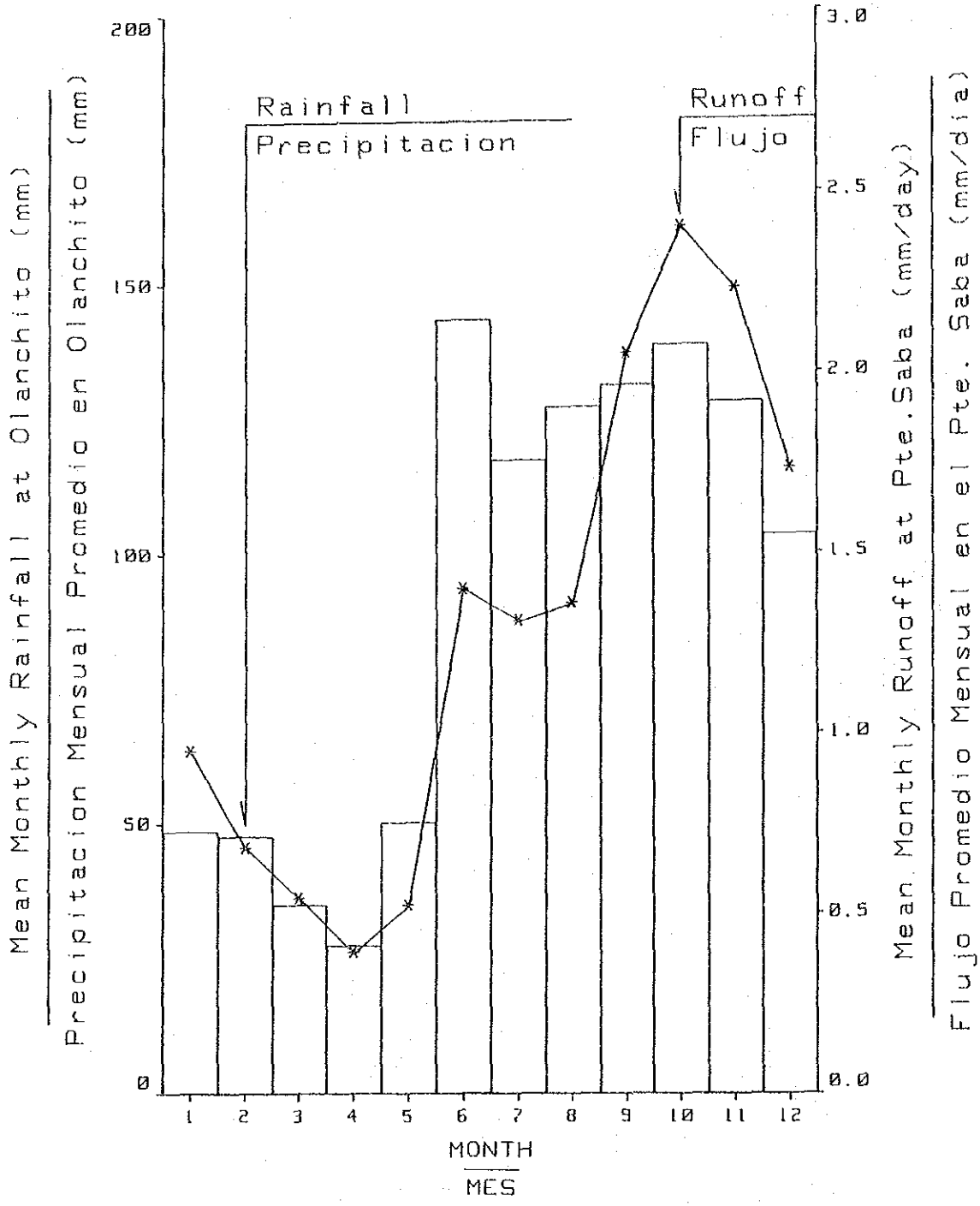


Fig. 3–5 PATTERN OF MEAN MONTHLY RAINFALL AND RUNOFF
PATRON DE PRECIPITATION PROMEDIO MENSUAL Y FLUJO

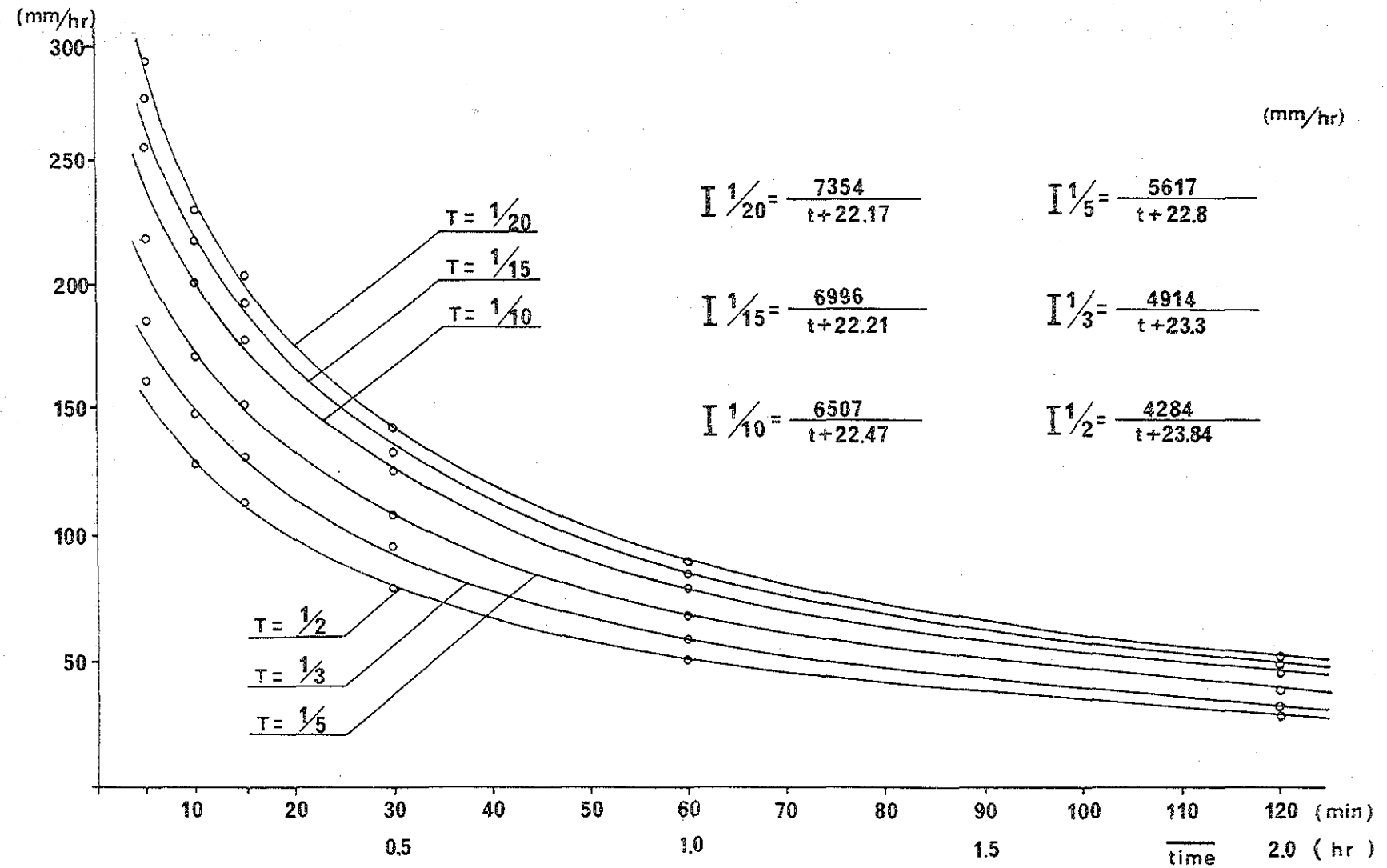


Fig. 3–6 FREQUENCY – INTENSITY – DURATION – CURVEY
FREQUENCIA – INTENSIDAD – PERIOD – CURVA

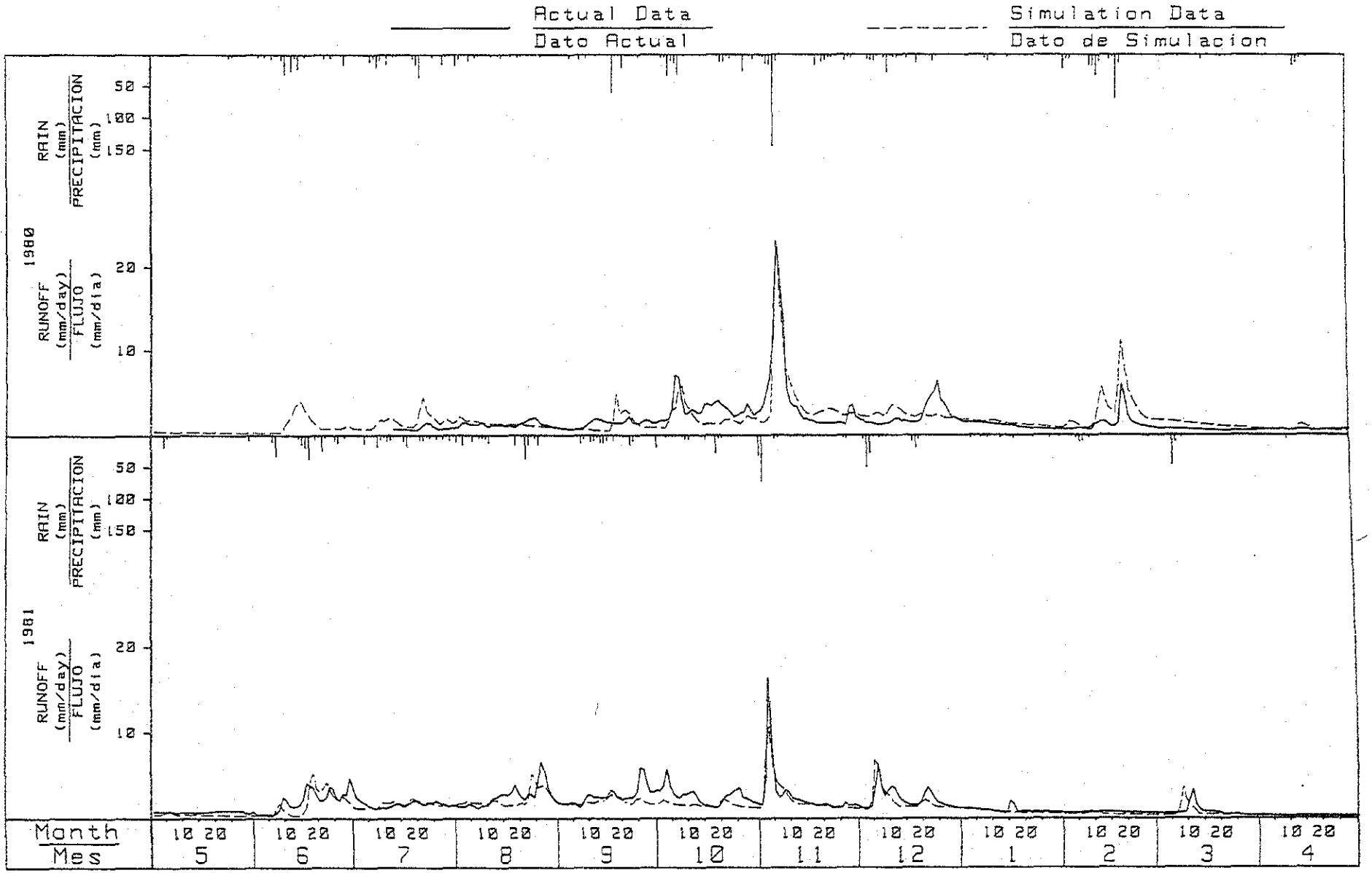


Fig. 3–7 PATTERN OF RAIN AND RUNOFF FROM MAY 1980 TO APR 1981
PATRON DE PRECIPITATION Y FLUJO DESDE MAYO DE 1980 HASTA ABR. DE 1981

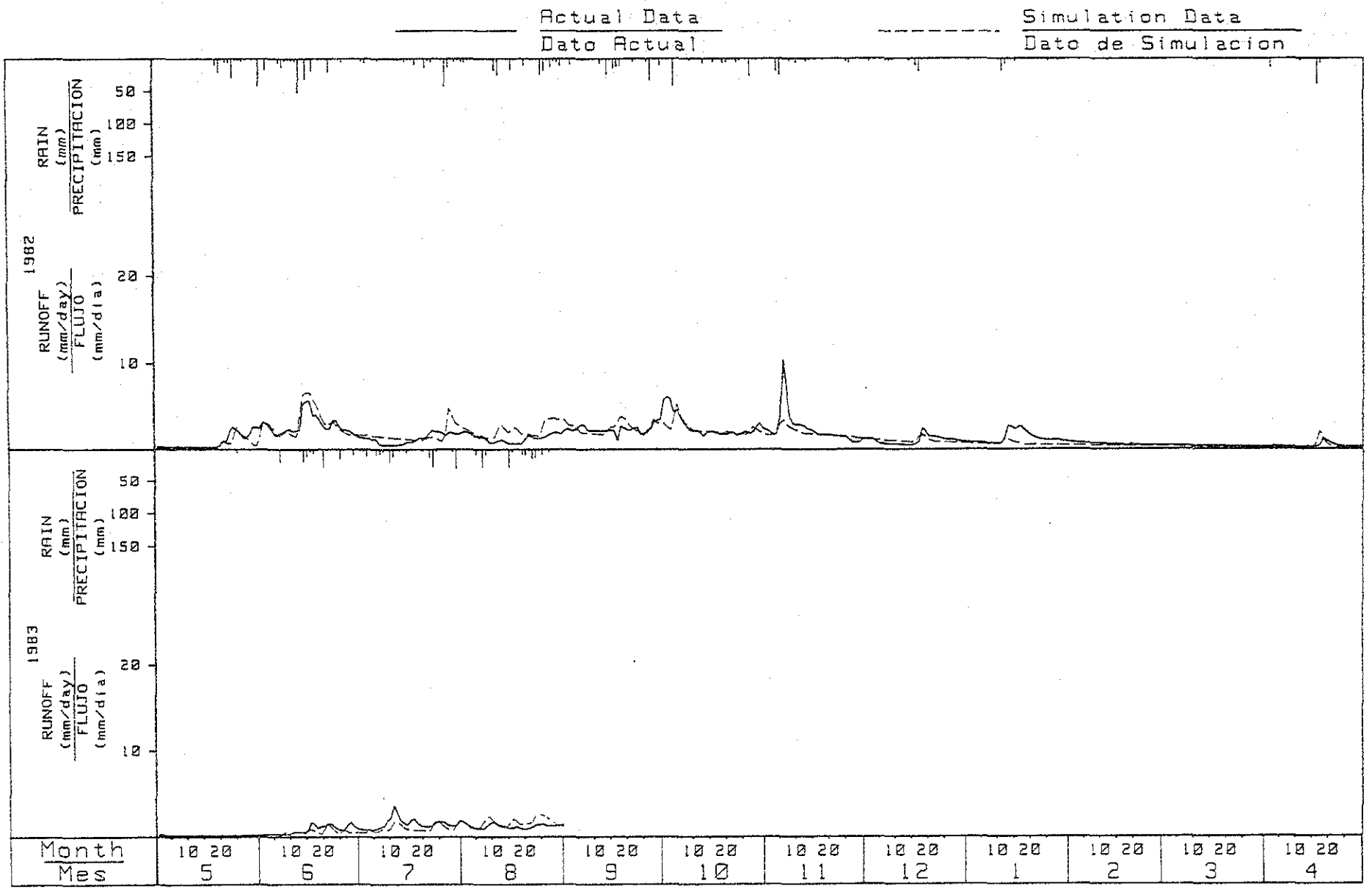


Fig. 3–8 PATTERN OF RAIN AND RUNOFF FROM MAY 1982 TO APR 1983
PATRON DE PRECIPITACION Y FLUJO DESDE MAYO DE 1982 HASTA ABR. DE 1983

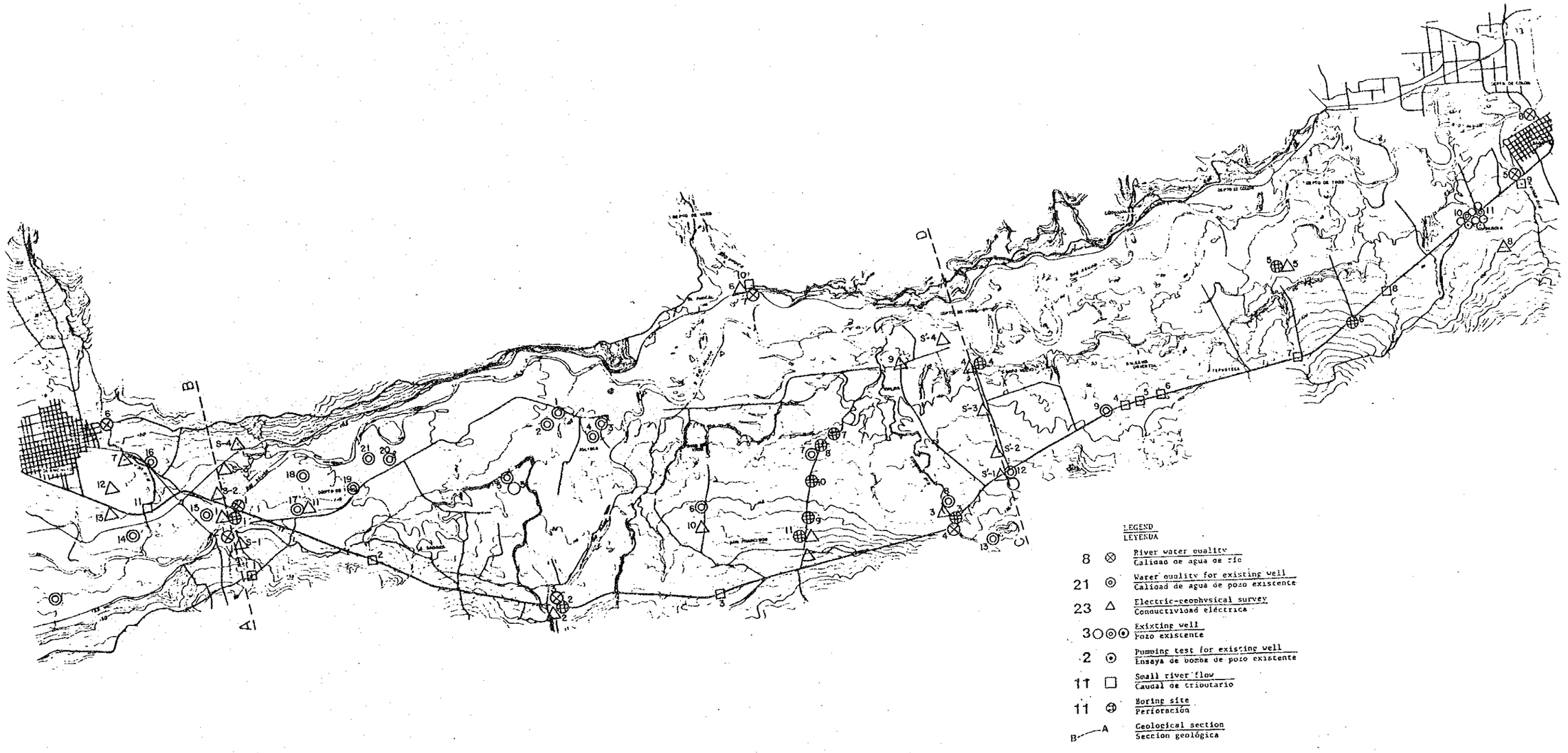


Fig. 3--9 INVESTIGATION POINT FOR WATER QUALITY, HYDROGEOLOGY AND GROUNDWATER
LUGAR DE INVESTIGACION DE CALIDAD DE AGUA, HIDROGEOLOGIA Y AGUAS SUBTERRANEAS

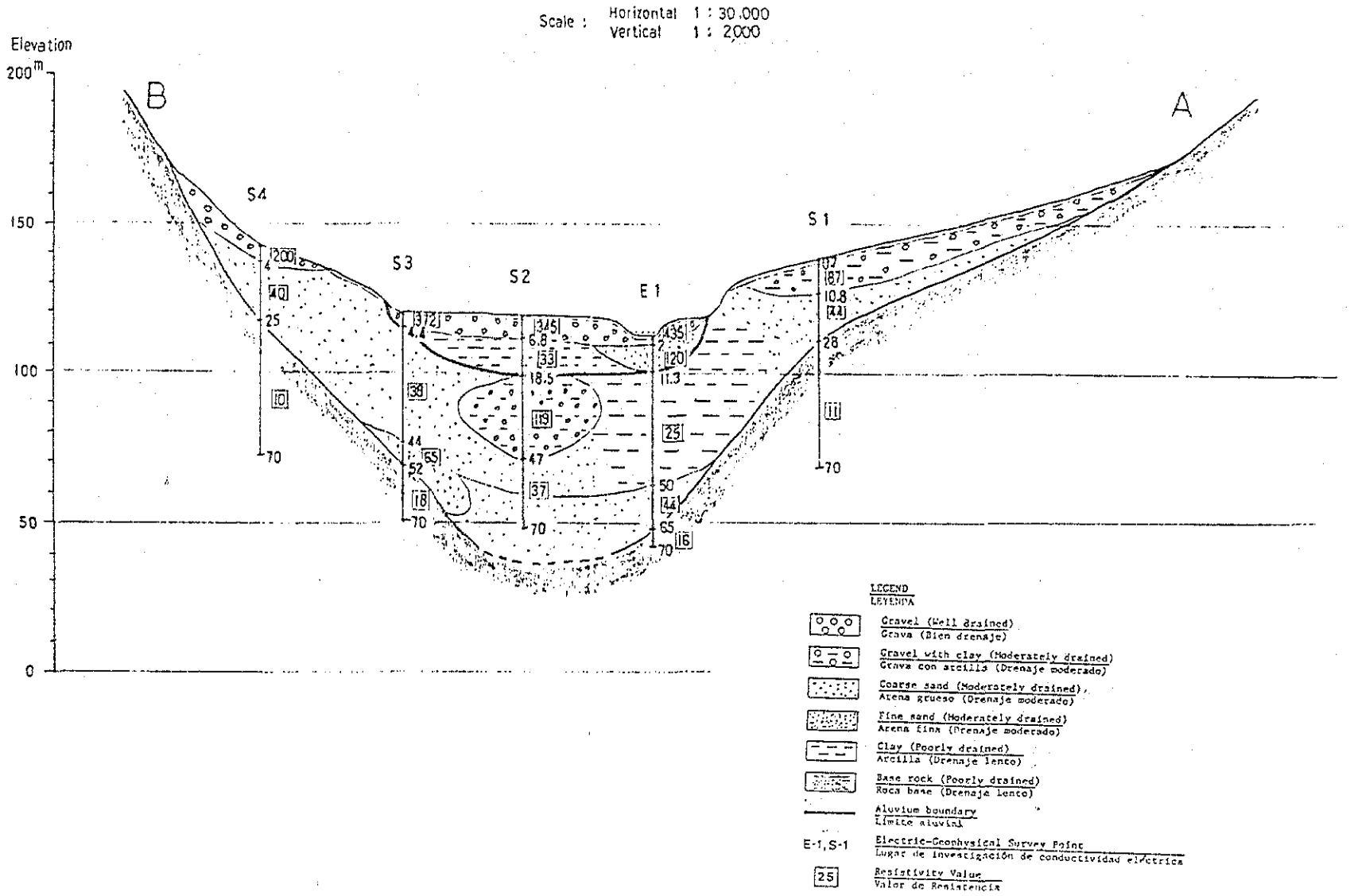


Fig. 3–10 AGUAN VALLEY GEOLOGICAL PROFILE (A–B)
PERFIL GEOLOGICO DEL VALLE DEL AGUAN (A–B)

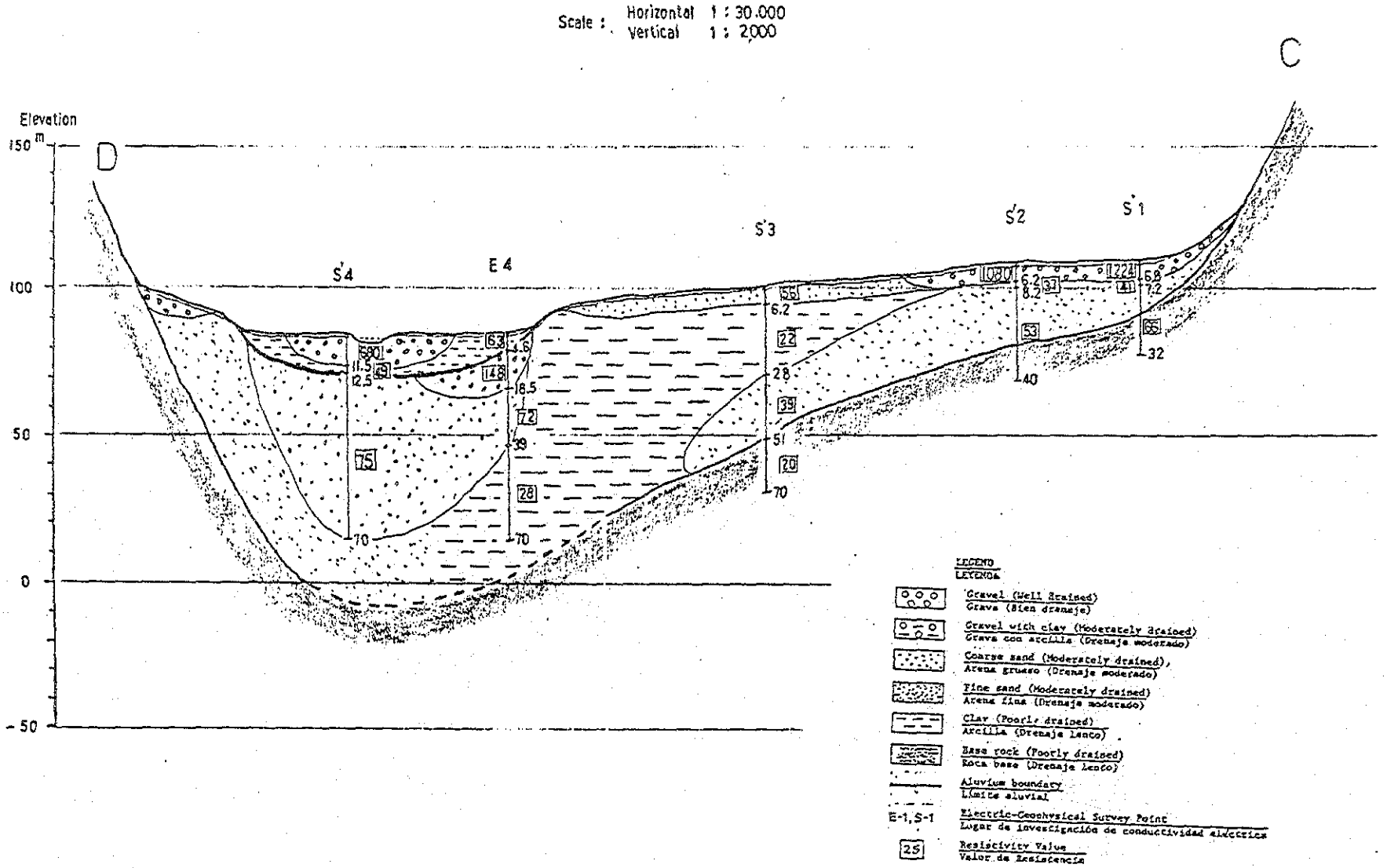
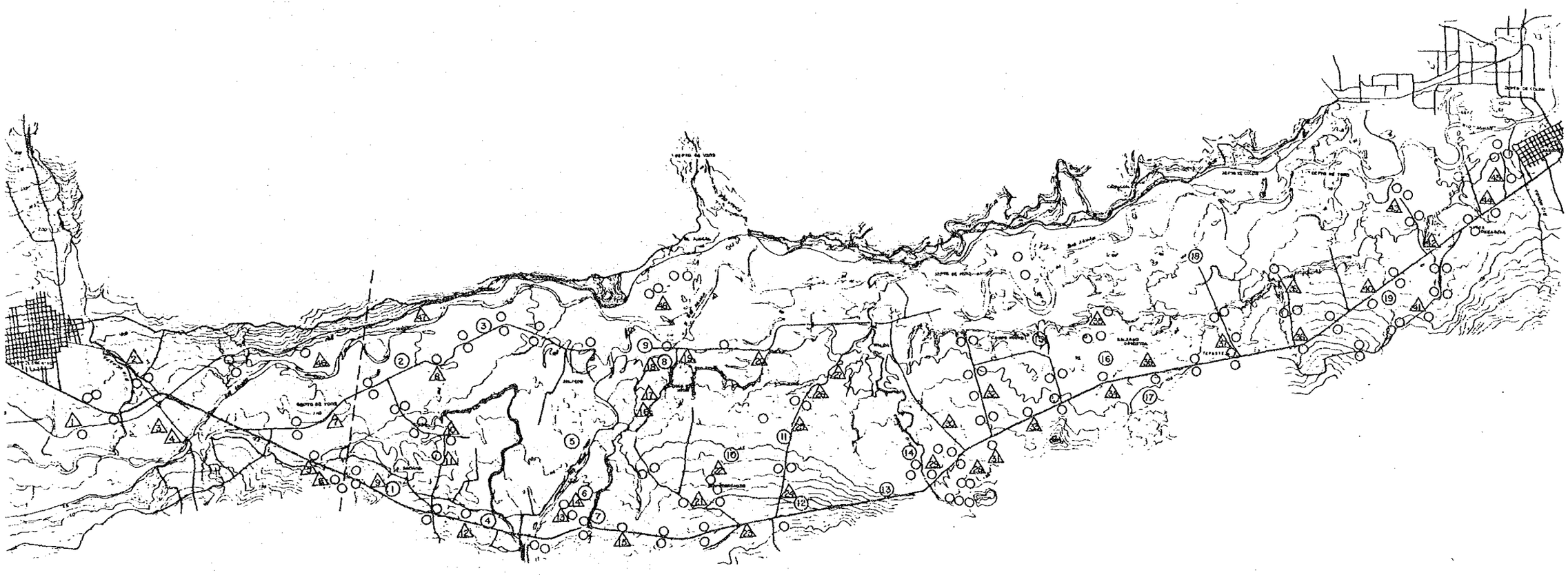


Fig. 3-11 AGUAN VALLEY GEOLOGICAL PROFILE (C–D)
PERFIL GEOLOGICO DEL VALLE DEL AGUAN (C–D)



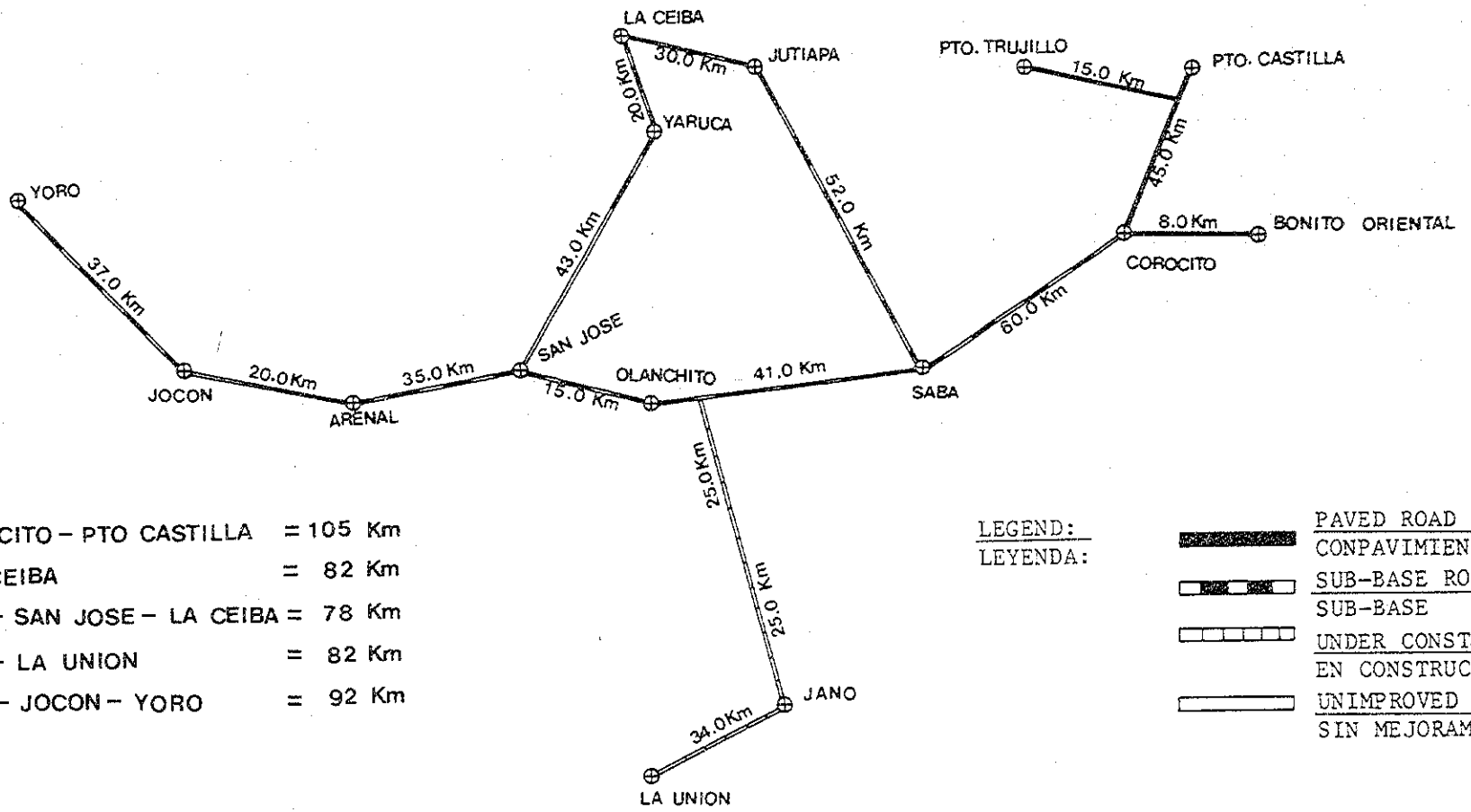
LEGEND
LEYENDA

○ Profile pit
Perfil

△ Boring point (For chemical analysis)
Perforación (Para análisis químico)

○ Boring point
Perforación

Fig. 3–12 PIT AND BORING POINT
LUGAR DE PERFIL Y PERFORACION



SABA – COROCITO – PTO CASTILLA = 105 Km
SABA – LA CEIBA = 82 Km
OLANCHITO – SAN JOSE – LA CEIBA = 78 Km
PTE MANE – LA UNION = 82 Km
OLANCHITO – JOCON – YORO = 92 Km

LEGEND:
LEYENDA:

PAVED ROAD
CONPAVIMIENTO
SUB-BASE ROAD
SUB-BASE
UNDER CONSTRUCTION
EN CONSTRUCCION
UNIMPROVED ROAD
SIN MEJORAMIENTO

Fig. 3–13 MAIN ROAD NETWORK IN THE AGUAN VALLEY
RED DE CARRETERAS PRINCIPALES DEL VALLE DE AGUAN

Table 3–1 RAINFALL CORRELATION CHART

STATION	PERIOD	4	5	6	7	9	11	13	15	16	18	%
4. YORIT	1973 - 83		0.625	0.758	0.735	0.624	0.607	0.447	0.734	0.531	0.502	6.84
5. OCOTAL	1973 - 83	0.625		0.728	0.693	0.554	0.714	0.646	0.647	0.598	0.513	6.83
6. LAGUATA, YORO	1973 - 83	0.758	0.728		0.807	0.622	0.712	0.546	0.795	0.726	0.624	10.56
7. MANGULILE	1973 - 83			0.807		0.701	0.631	0.576	0.861	0.645	0.594	8.51
9. YOCON	1973 - 83				0.701		0.532	0.415	0.651	0.502	0.504	10.11
11. JOCON	1973 - 83			0.712	0.631			0.498	0.671	0.583	0.504	7.28
13. SAN LORENZO	1972 - 84	0.447		0.546					0.539	0.669	0.622	8.22
15. LA GUATA OLANCHO	1973 - 83					0.651				0.603	0.579	20.67
16. COYOLES	1973 - 82										0.841	7.10
18. OLANCHITO	1972 - 84	0.502	0.513	0.624	0.574	0.504	0.504	0.622	0.579	0.841		13.88
· AVERAGE	–	0.776	0.842	0.896	0.913	0.840	0.751	0.751	0.907	0.804	0.701	100.00

Table 3–2 ANNUAL RAINFALL AND RUNOFF

YEAR	Annual Rainfall at Olanchito (mm)		Mean Annual Runoff at Pte. SABA (mm/day)	
1973	661	(0.60)	0.53	(0.41)
74	1,136	(1.04)	1.44	(1.11)
75	903	(0.82)	0.73	(0.72)
76	779	(0.71)	0.66	(0.51)
77	948	(0.87)	0.99	(0.76)
78	1,287	(1.17)	1.36	(1.05)
79	1,658	(1.51)	2.41	(1.85)
80	1,209	(1.10)	1.68	(1.29)
81	1,280	(1.17)	1.76	(1.35)
82	1,157	(1.06)	1.42	(1.09)
83	1,040	(0.75)	1.08	(0.83)
Average	1,096	(1.00)	1.30	(1.00)

Table 3–3 PATTERN OF MEAN MONTHLY RAINFALL AND RUNOFF

MONTH	Rainfall at Olanchito		Runoff at Pte.SABA	
	mm	%	mm/day	
1	48.6	(4.4)	0.95	(0.73)
2	47.6	(4.3)	0.67	(0.52)
3	34.9	(3.2)	0.54	(0.42)
4	27.4	(2.5)	0.39	(0.30)
5	50.2	(4.6)	0.52	(0.40)
6	143.3	(13.1)	1.40	(1.08)
7	117.2	(10.7)	1.31	(1.01)
8	127.2	(11.6)	1.36	(1.05)
9	130.5	(11.9)	2.05	(1.58)
10	138.4	(12.6)	2.40	(1.85)
11	128.2	(11.7)	2.23	(1.72)
12	103.3	(9.4)	1.73	(1.33)
Annual	1,096.8	(100.0)	1.30	(1.00)

Table 3-4 MEAN MONTHLY RAINFALL

(mm)

Month	11 YEARS AVERAGE	RETURN PERIOD			
		1/2	1/3	1/5	1/10
1	48.6	47.2 (44.0)	41.3 (38.7)	37.0 (34.8)	32.6 (30.8)
2	47.6	46.2 (43.1)	40.5 (38.0)	36.2 (34.1)	31.9 (30.2)
3	34.9	33.8 (31.9)	29.7 (28.1)	26.5 (25.2)	23.4 (22.3)
4	27.4	26.6 (25.2)	23.3 (22.2)	20.8 (20.0)	18.4 (17.7)
5	50.2	48.7 (45.4)	42.7 (39.9)	38.1 (35.9)	33.6 (31.7)
6	143.3	139.0 (98.3)	121.8 (92.4)	108.9 (87.6)	96.0 (80.9)
7	117.2	113.7 (89.5)	99.6 (83.1)	89.1 (76.6)	78.5 (69.4)
8	127.0	123.2 (92.8)	108.0 (87.2)	96.5 (81.3)	85.1 (73.9)
9	131.0	127.2 (94.0)	111.4 (88.6)	99.6 (83.1)	87.8 (75.7)
10	138.4	134.3 (96.7)	117.6 (91.0)	105.2 (86.0)	92.7 (78.9)
11	127.8	124.0 (93.1)	108.6 (87.5)	97.1 (81.6)	85.6 (74.3)
12	103.3	100.2 (83.5)	87.8 (75.8)	78.5 (69.5)	69.2 (62.4)
Annual	1,046.8	1,063.9 (837.5)	932.3 (772.4)	833.6 (715.5)	734.8 (648.3)

* ( ) : Effective rainfall

Table 3-5 MEAN MONTHLY RUNOFF AT PTE SABA

Unit: mm/day

Month	11 Years Average	RETURN PERIOD			
		1/2	1/3	1/5	1/10
1	0.95	0.89	0.70	0.57	0.45
2	0.68	0.63	0.50	0.41	0.32
3	0.54	0.50	0.40	0.32	0.25
4	0.39	0.36	0.29	0.23	0.18
5	0.52	0.48	0.38	0.31	0.24
6	1.40	1.31	1.04	0.84	0.66
7	1.31	1.22	0.97	0.78	0.61
8	1.36	1.27	1.01	0.82	0.64
9	2.05	1.91	1.52	1.23	0.96
10	2.40	2.24	1.78	1.44	1.13
11	2.23	2.07	1.65	1.34	1.05
12	1.73	1.61	1.28	1.04	0.81
Mean Annual	1.30	1.21	0.96	0.78	0.61

Table 3-6 RIVER FLOW AT PTE. SABA

(Low Discharge)
m^3/sec

Return Period / Month	1/2	1/3	1/5	1/10
Jan.	77.34	61.36	49.86	38.99
Feb.	55.09	43.71	35.52	27.77
Mar.	43.63	34.61	28.12	21.99
Apr.	31.80	25.23	20.50	16.03
May	42.00	33.32	27.07	21.17
Jun	114.17	90.58	73.60	57.56
Jul.	106.26	84.30	68.50	53.57
Aug.	110.99	88.06	71.55	55.95
Sep.	167.04	132.53	107.68	84.21
Oct.	195.51	155.11	126.03	98.56
Nov.	181.16	143.73	116.78	91.33
Dec.	140.42	111.41	90.52	70.79
MEAN	105.67	83.83	68.11	53.27

Table 3-7 MAXIMUM MEAN DAILY RUNOFF FOR EACH YEAR (PTE. SABA)

YEAR	RUNOFF	DISCHARGE	RATIO	REMARK
	mm/day	m^3/s		
1973	3.38	295	0.25	TANK MODE
74	25.88	2,260	1.94	"
75	5.86	512	0.44	"
76	5.14	449	0.39	"
77	13.68	1,194	1.03	"
78	8.28	723	0.62	"
79	17.44	1,522	1.31	"
80	23.13	2,020	1.75	ACTUAL DATA
81	16.47	1,438	1.23	"
82	10.42	910	0.78	"
83	16.87	1,473	1.27	"
MEAN	13.32	1,163	1.00	

Table 3-8 PROBABILITY OF MAXIMUM DISCHARGE

RETURN PERIOD	RUNOFF	Pte. SABA		Pte. OLANCHITO	
		DAILY	PEAK	DAILY	PEAK
	mm/day	m^3/s	m^3/s	m^3/s	m^3/s
1/2	12.71	1,110	2,050	690	1,600
1/3	17.40	1,520	2,480	950	1,900
1/5	23.36	2,040	2,950	1,270	2,250
1/10	29.31	2,560	3,500	1,600	2,700

Table 3–9 CHEMICAL CHARACTERISTICS

Symbol	Item / Depth	Number of sample	pH	EC mmho/cm	Humus	No_3-N mg/100g	P_2O_5 Bray mg/100g	P_2O_5 Truog mg/100g	K meq/100g	Ca meq/100g	Mg meq/100g	CEC meq/100g
Ab	top soil	6	6.5	0.074	1.9	1.3	22.6	26.2	0.8	11.2	1.7	19.3
	sub soil	3	6.5	0.027	0.8	1.5	10.0	13.7	0.5	8.2	0.7	10.4
Ag	top soil	11	6.8	0.094	2.5	1.4	23.6	27.1	0.7	16.0	2.5	26.3
	sub soil	7	6.8	0.063	1.3	1.1	9.5	19.0	0.3	17.9	1.8	19.9
Te	top soil	5	5.9	0.050	18.1	1.1	24.8	9.9	1.3	13.2	2.8	43.5
	sub soil	3	5.9	0.039	13.8	1.9	12.2	1.8	0.5	8.6	0.8	28.9
Ol	top soil	7	6.7	0.050	3.3	2.1	10.9	13.3	1.0	7.3	1.4	16.3
	sub soil	3	6.8	0.038	1.8	2.3	4.9	9.7	0.8	6.4	0.5	15.0
Il	top soil	3	6.2	0.059	2.2	0.9	9.9	9.4	0.5	9.1	1.4	17.9
	sub soil	3	6.1	0.033	2.2	1.0	7.2	5.4	0.5	6.9	0.9	12.2
Tj	top soil	4	6.2	0.063	3.6	2.5	6.2	5.7	1.2	7.9	2.1	18.5
	sub soil	3	5.8	0.025	2.4	1.1	1.5	1.3	0.6	5.0	0.5	11.1
Ja	top soil	6	6.4	0.076	4.5	1.6	15.6	15.7	1.0	11.3	2.2	25.3
	sub soil	7	6.2	0.044	1.7	1.8	3.7	1.2	0.6	10.3	2.2	18.2
Am	top soil	5	5.9	0.049	3.1	1.1	7.2	6.1	0.3	8.9	1.9	22.2
	sub soil	4	6.1	0.029	1.2	1.7	4.9	6.0	0.3	7.8	1.3	15.1

Table 3–10 SOIL PROPERTIES

Symbol	Name	Depth	Parent Material	Relief Class	Texture	Drainage	Acidity	CEC	Fertility	Recomended Landuse	Area	
											ha	%
Ab	Fine Texture Well Drained Alluvium	Top soil	Gravel	Flat	Medium	Good	Moderate	Medium	Medium	Upland crop	2,990	14
		Sub soil			Coarse		Moderate	Low				
Ag	Aguan Clay Loam	Top soil	Gravel	Flat	Medium	Moderate	Moderate	High	High	Upland crop	6,500	31
		Sub soil			Medium		Moderate	Medium				
Te	Tepusteca Loam	Top soil	Tuff	Flat	Medium	Moderate	Slightly acid	High	High	Upland crop	780	4
		Sub soil			Medium		Slightly acid	High				
Ol	Olanchito Sandy Loam	Top soil	Gravel	Flat to undulating	Coarse	Moderate	Moderate	Medium	Medium	Grassland	2,600	13
		Sub soil			Coarse		Moderate					
Il	Ilanga Sandy Clay	Top soil	Gravel	Flat to undulating	Fine to Medium	Moderate to poor	Moderate	Medium	Medium	Upland crop	520	3
		Sub soil			Fine to Medium		Moderate	Low				
Tj	Taujica Clay Loam	Top soil	Gravel	Flat to undulating	Fine to Medium	Moderate to poor	Moderate	Medium	Medium	Upland crop	1,230	6
		Sub soil			Medium		Slightly Acid	Low				
Ja	Jahuaca Clay Loam	Top soil	Gravel	Flat	Medium	Moderate to poor	Moderate	High	High	Upland crop	5,850	28
		Sub soil			Medium		Moderate	Medium				
Am	Fine Texture, Poorly Drainage Alluvium	Top soil	Gravel	Flat	Medium Fine	Poor	Slightly Acid	Medium	Medium	Paddy	200	1
		Sub soil					Moderate	Medium				

* The table was summaerized based on the criteria as follows:

Texture = Coarse (s.LS.SL.) Medium (other types except for coarse and fine types) Fine (HC,S.E,L.C,Sc).

Acidity = Slightly Acid (5.0--6.0), Moderate (6.0--8.0).

C.E.C = Low (15>), Medium (15-25), High (25<)

Fertility = It is based on total nutrient condition.

Table 3-11 ACTUAL LAND USE OF STUDY AREA

Crop	Crop Season	
	Primavera	Postrera
Maize	1,694 ha	2,019 ha
Rice: dryland	302	
Beans	80	178
Cassave	21	
Plantains	7	
Oranges	130	
Other fruit trees	15	
Pasture (cooperative)	1,394	
Improved pasture	3,600	
Independent farmers' pasture	2,718	
Uncleared (cooperative)	4,194	
Unused	1,645	
Total	15,800	2,197

Table 3–12 CULTIVATED ACREAGE OF COOPERATIVES

	Distributed Area	No. of Member	Maize (ha)		Beans (ha)		Rice (ha)	Cassava	Plantain	Pasture (No. of Cows)	Cultivated Area
			Primavera	Postrera	Primavera	Postrera					
1.	161	22	31.5	56.7						42 ha	73.5ha
2.	77	15	21	14			2.1			20	43.1
3.	28	14	10	21						5	15
4.	40	21	21	28		4				10.5	31.5
5.	105	13	52.5	41.3						52.5	105
6.	40	14	10	15.4			3			8	21
7.	98	43	60.2	56			4.2			31 (86)	95.4
8.	126	12	28	28						77 (217)	105
9.	88	27	25.2	42	6		6			47.6	84.8
10.	201	22	11.2	14	7	15.5	5.6			105	128.8
11.	161	22	42	70			10.5	1		131.6 (41)	185.1
12.	100	18		15.4							-
13.	56	14	11.2	14			6			6	23.2
14.	504	87	142	105				13		42 (20)	197
15.	489	58	84	105			28			140	252
16.	467	70	70	125		15.5		0.5		105 (10)	175.5
17.	459	56	133	119			7	1		35	176
18.	500	36	51.8	96	14		21.7	2		91	180.5
19.	402	55	79.5	140		42	35			35 (90)	149.5
20.	554	47	151.9	255		7	35			105 (28)	291.9
21.	486	44	90.6	93.8	15.4	7	25			56 (21)	187
22.	490	72	94.5	100	28	15	63			40	225.5
23.	499	67	60.9	88.4		7		1.5		32.2 (40)	94.6
24.	489	45	84	105	10	35	21		7	88 (24)	210
25.	515	51	229	161		35	14			40	283
26.	546	67	99.4	109			15	2		49 (28)	165.4
	7,681	1,012	1,694.4	2,018	80.4	183	302.1	21	7	1,394.4(605)	3,499.3

Table 3-13 YIELD OF MAIZE, BEANS AND RICE

Co.	Maize (ton)		Beans (ton)		Rice (ton)
	Prim.	Post.	Prim.	Post.	Primavera
1	2	2			
2	2	2			2.5
3	2	2			
4	1.5	2	1		
5	2	2			
6	1.8	2			2
7	2	2			2
8	3	3			2.5
9	1.8	2	1.5		2.5
10	2.5	2.5	1.3		2
11	3	3			4
12		2			2.5
13	2	2.3			2.5
14	2	2.5			
15	1.8	2	1	1.2	2
16	2	2		1	2.5
17	1.8	2			2.5
18	2	2.5	1.2		2.8
19	2	2.5		1	4
20	2.3	1.8		1	2.5
21	1.5	2	1		2
22	2	2.3	1		3.3
23	1.8	2		1	
24	1.8	3	1		2.5
25	2.5	3	1	1	3.5
26	2	2.3			2.5

CO: Cooperative Post.: Postrera Prim.: Primavera

Table 3--14 FARM MANAGEMENT IN COOPERATIVES

	Cooperative	Precedence (Department)	Location	Distributed Area	No. of Member (Initial)	Distance (km)	Loan (Up-to-date)	Popu-lation	Maize				Rice			Beans	Other Works			
									Col. mz Ind		Yield d/m qq		qq	col	Ind					
Río Jaguaca - Saba (sector 5)	Lomitas (77:A)	Native Yoro 37 Colon 30	Lomitas	546	(27) 64	0.1	12 vacas 7/81	3	70	80	40	6,000	0	0		0		15-20	C	C:Coyoles
	4 de Enero (81:A)	Morazán 60% Ocotepeque Copán 10%	NVA Lombardilla	515	(34) 53	0.5	3.194 maiz BANADESA 6/84	10 324	27	300	50	16,350	0	20	40		No	9-15	C	
	Agua Caliente (79:A)	Valle 35 Yoro 6	A. Caliente	489	(18) 45	0.1	3,450 Platanos	32 176	40	80	40	4,800	10	40					C	
	12 de Diciembre I (79:A)	Copan 40 Intimaca 8	Monga	248	(35) 52	1	No	6 300	34	266	50	15,000	0	0		0		9-15	C	
	12 de Diciembre II (83:F)	Intibuca 20 Yoro 12 Copan 2		248	(27) 36		No	2 192	64	43	60	6,420	0	0		0		75-15	C	
	Brisas de Monga (82:F)	Olancho 30, Intibura 25, Copan 9	Los Cocos	495	(14) 75	3	No	2 450	6	130	30	3,900	0	4	50	0	(120)	10-13	C	
	El Agricultor (81:A)	Choltteca 27 Yoro 5, Valle 4 Santa Barbara 3	Tepusteca	484	(26) 46	2.5	2000 Maiz BANADESA 8/84	3 221	20	110	40	5,200	0	0		0		10-15	C	
	21 de Abril (78:A)	Yoro 20, Olancho 9 Choltoca 4	Tepusteca	554	(12) 39	3	2,400 Maiz	0 219	65	105	30	5,100	0	0		0	No	11-16	C	
	Tepusteca (75:F)	Yoro 30, Colon 9, Olancho 5	Tepusteca	402	(23) 54	2	1,000 Insumo	20 259	15	100	35	4,025	0	0		0	No	10-18	C	
	Perlas del Aguán (82:A)	Copan 10, Atlantida 9, Yoro 5, Colon 5, Lempira 3	Bálsamo	500	(57) 34	2	5,000 Platano COSUDE 3/84	5 184	38	36	60	4,440	5	18	50	15	No	10-12.5	C	
	Brisas de Cuyamapa (81:A)	Valle 18, Choltora 17, Copan 10, Conayagua 4	San Luis	459	(35) 52	3-4	5,000 destroncar	2 287	110	56	40	7,600	10	0	40	0 50 MZ	No	9-14	C	
	Fe y Esperanza (81:A)	Choltteca 31, Yoro 16 Valle 13, Colon 5 Copan 4, Olanchol	San Luis	466	(13) 70	1.5	11,000 5 bueyes 6,500	6 478	125	140	20	5,300	0	30	70	0	No.	8-20	C	
	Campo Nuevo (79:A)	Choltteca 25, Yoro 15, Lopan 10, Santa Barbara 6	Campo Nuevo	489	(12) 58	1	8,800 Arroz BANADESA 83 en Mora 7,000	5 344	80	40	60	7,200	0	40		0		9-12.5	C	
		Copan 39, Lempira 15, Yoro 8, Santa Barbara 7, Comayagua 5	Armenia	504	(13) 87	2.5	1650 Maiz BANADESA 83 Cancelado	8 572	25	170	40	7,800					.	9-13	C	
	Carbajales (L) (76:I)	Lempira 82, Yoro 47 Olancho 15, Atlantida 11, and Others	Carbajales	487	(96) 167		No	141 913	71.4 659.4	428.6 2265.6		25,000 24,805	0	28.6	20-25	3 ha Ind.		10-35	I	I:Isleta
El Puente (Uchapa) - Río Name - Río Jaguaca	San Francisco I (69:A)	Yoro 12 Copan 6	San Francisco	161	(14) 18		4,000 BANADESA 83		0	60	60 2	3,600	15	0	50		6 months			
	San Francisco II (83:A)	Yoro 13 Copan 4 Olancho 2	San Francisco	100	(23) 19	1	No	10	0	0			0	0		0				
	San Rafael (L) (72 A)	Yoro 14	San Rafael	56	(20) 24			138	0	45	40	1,800	0	0			2 months Lp 5			
	El Agulla (79:A)	Yoro 19 Olancho 2 Cholteca 1	El Barranco	200	22		50% del costo BANADESA 83		0	16	50	800	10	10	50		Lp 6			
	Sabena de San Carbos	Yoro 28	Sabana S. Ca.	27	28		No		0	36	40	1,440	0	0						
	Uchapita (69:A)	Yoro 10 Copan 2 Valle 1	Potrerillos	105	(37) 13	1	No		0	75	40-45	3,150	0	0		6				
	Puerto Escondido (69:A)	Yoro 32 Lempira, Valle Atlantida	Puerto Escondido	98	(36) 40	1.5	No	200	0	86	40	3,440	0	5	60	0	4 months Lp 5	8-12	C	
	Valle Aguan (69:A)	Yoro 12	Mendez	126	(26) 12		120,000	7 54		40	50-68	1,400	0	0		0	No			
	El Juncal	Yoro 18 Olancho 3	El Juncal	40	21	3	No	6 115	0	30	30	900	0	0		0		12-25	I	
	La Pimianta (L) (83:A)	Yoro 15	El Jicalo	28	(17) 14	1	No	5 75	00	14	40	560	0	0		0	2 months Lp 5	13-	01	
	El Chaperval (69 A)	Yoro 15	El Chaparral	77	(36) 15	2	500 maiz BANADESA 83	6 41	14 150	16 258	40 47	1,200 19,160				0	2 months Lp 5	16 5-9	IHMA C	

Table 3-15 SETTLERS AND DESERTERS FOR EACH COOPERATIVE DURING 1979 – 1980

COOPERATIVES	TOTAL No. OF SETTLER	TOTAL No. OF DESERTER	% OF DESERTION
1. Brisas de S. Pedro	15	15	100
2. La Conflanza	15	14	993.3
3. Coloneña	12	11	91.7
4. La Boveda	17	14	82.4
5. Nueva Jerusalem	14	10	71.4
6. Los Leones	17	10	58.8
7. Las Mercedes Aguan	14	8	57.1
8. Despertar	27	15	56.6
9. Corocito	38	21	55.3
10. Nueva Distancia	17	7	41.2
11. Colon	21	8	38.1
12. Brisa del Aguan	21	6	28.6
13. Trece de Junio	46	11	23.9
14. Quebrada Honda	43	10	23.3
15. El Remolio	42	8	19.1
16. Honduras Aguan	41	7	17.1
17. Buena Fe	48	5	10.4
18. Esfuerzos Masicales	207	6	2.9
TOTAL	655	186	28.4

Source: Desenvolvimiento del Programa de Migraciones Inducidas 1979-1980 INA-UNDP

Table 3-16 PUBLIC HEALTH CENTER

	CESAMO		CESAR
	OLANCHITO	SABA	TEPUSTECA
No. of Doctor	4	2	-
No. of Nurses (including assistance)	11	3	1
Laboratories	Yes	No	No
No. of Patients per day	140	30	40
Business Hours	7 a.m. 12 a.m.	7 a.m. 3 p.m.	7 a.m. 12 a.m.
Service of Vaccination	Yes	Yes	Yes

N.B.

1) The patient pays L1.00 when they receive medical service at CESAMO.

2) It is reported that many patients, for example CESAMO of Olanchito, 70 patients daily could not receive medical services due to the lack of doctors.

Table 3–17 GENERAL FEATURES OF PRIMARY SCHOOL IN OLANCHITO

	NO. OF SCHOOLS	NO. OF PUPILS	AVERAGE NO. OF PUPILS PER EACH SCHOOL	NO. OF TEACHERS	AVERAGE NO. OF TEACHER PER SCHOOL	AVERAGE NO. OF PUPIL PER TEACHER
URBAN	4	2,299	574.75	67	16.75	34.3
RURAL	45	4,372	97.16	93	2.07	47.01
PRIVATE	1	89	89	9	9	9.89

Source: PLAN ANUAL DE TRABAJO, DISTRITO ESCOLAR No. 2 OLANCHITO, YORO. ANÕ 1984

Table 3–18 REGISTERED PUPILS BY GRADE AND FOR AGE IN RURAL SCHOOL

GRADE	FIRST		SECOND		THIRD		FOURTH		FIFTH		SIXTH		TOTAL	
AGE	G	B	G	B	G	B	G	B	G	B	G	B	G	B
6	2	-	-	-	-	-	-	-	-	-	-	-	2	-
7	7	11	1	-	-	-	-	-	-	-	-	-	8	11
8	5	4	5	5	1	-	-	-	-	-	-	-	11	9
9	3	6	3	4	5	5							11	15
10	2	3	3	4	5	5							12	15
11	1	-	2	8	3	3	2	3	1	3	1	-	10	17
12	-	1	4	1			3	8	5	1	3	3	15	14
13	4	2	-	-	2	1	4	4	4	7	10	6	24	20
TOTAL	24	27	19	23	13	14	12	16	11	12	14	9	93	101

N.B.: G: Girl
B: Boy

CHAPTER 4 : FORMULATION OF THE BASIC DEVELOPMENT CONCEPTS

CHAPTER 4 FORMULATION OF THE BASIC DEVELOPMENT CONCEPTS

4.1 Objective

The development of the agricultural sector is a very important factor for the social and economic improvement of the country. In line with this strategy, the development of the Lower Aguan Valley has been carried out since 1970. In consideration of the importance of the continuous development of the Aguan Region, the feasibility study for the development of the Middle Aguan Valley was requested by the Government of Honduras.

To date, of the total project area only limited area has been developed for the cultivation of basic grains and pastures, the remainder being left uncultivated. The benefits of such agricultural infrastructure works as irrigation and drainage systems and road network will fall into the following positive economic and social impacts.

(1) The provision of new irrigation and drainage systems makes it possible to realize the introduction of non-traditional crops, the improvement of quality in crops and the increase for productivity.

(2) The improvement of in-farm road network will bring the mechanization of farm operation practice and, as a result, labor saving and efficient transportation of agricultural inputs and harvested crops.

(3) The stable agricultural output will result in the increase of net incomes among farmers together with creating new settlement opportunity of approximately 2,000 families.

The implementation of this project associated with the improvement of agricultural infrastructures aims at to realize the development of agricultural and livestock sectors in the project area and to serve as to fulfill the national economic and social objectives.

4.2 Basic Development Concepts

The basic development concepts are to be formulated taking into account the natural and socio-economic features of the development area.

Distinctive features of the development area may be summarized as follows:

1) Land is characterized by its fertility and selection of cropping patterns is not constrained by such physical conditions as soils and climate.

2) No artificial irrigation and drainage systems are consolidated and crops are cultivated depending on rainfall.

3) The mild slope of the development area will permit the improvement of some poor drainage areas without difficulty except for where heavy clay soils dominate.

4) Agricultural production is practiced inefficiently due to the lack of consolidation for access and in-farm roads.

5) Port facilities as transport infrastructures are located in La Ceiba and Puert Castilla. In addition, road network to link with thse ports are being consolidate.

6) Cropping technology and capital saving of proposed farmers to be settled in the development area are maintained in low-level.

Considering these natural and socio-econoic features, the general frameworks of the basic development plan have been drawn up as briefly summarized below.

1) New irrigation systems have been introduced so as to attain a stable rotation of crop cultivation and planned agricultural practice as well as increase in production and the quality control.

2) With regard to irrigation system which attains greater importance to the total project cost, attention has been laid on the planning of the most appropriate facilities to suit the development area. For this purpose, comprehensive studies on water resources, topography and soils etc. have been made to examine technical and economical feasibility of the Project.

3) Taking into account topographic, soils and social conditions and future introduction of agricultural machineries, farm lot, irrigation and drainage systems and road network have been laid out in such a manner as to enable the land use with work efficiency.

4) In terms of the realization of agricultural practice with advanced technology and high productivity, it is essential to learn new cropping technology and introduce agricultural machineries. In order to attain these aims, it is necessary to realize stable farm management and capital saving and, for this purpose, croping pattern emphasized on the introduction of basic grains at the initial stage of the Project have been proposed.

5) Flexible land use and facilities to adapt to future changing of cropping patterns have been set out.

4.2.1 Development Area

Of the total project area of 20,655 hectares, 16,824 hectares will be available for agricultural development, the remainder being not feasible for agricultural use: residential area (279 ha), rivers

and roads (1,521 ha) and lands with a slope of more than 8% (2,031 ha). About 6 - 7% of the development land will be allocated to such infrastructure projects as in farm roads and irrigation and drainage systems. Consequently, the arable area will be calculated as approximately 15,800 hectares. (See Fig. 4-1)

Lands having a slope of more than 8% have been excluded from the development area, in view of labor efficiency for the establishment of mechanized agriculture in the future. With the improvement of the in-farm road network and adjustment of farm lot sizes (approx. 500 ha per block) mechanized agriculture is envisaged in the development area. This will be especially true in the case of lands where cultivation of permanent crops will be encouraged and thus farm management utilizing large-scale agricultural machinery will be required for application of fertilizer and pesticides and harvest of crops.

4.2.2 Irrigation Scheme

As the base for the planning of irrigation methods, water intake, (diversions, pumping from rivers and pumping from groundwater), water conveyance canals and water distribution systems to farmland should be considered. Various alternatives may be proposed for irrigation methods and the selection among these alternatives will be made, studying their technical and economic feasibility.

At present, investigations on topographical sloping, soil conditions, groundwater level and crops have led to the conclusion that the furrow or border irrigation system is the most appropriate scheme for the project area.

The location of suitable water intake sites is to be determined after studying such factors as water supply volume, ground elevation, the slope of the conveyance canal and irrigable area. Among these factors, groundwater elevation and water supply volume are the most important.

The average ground elevations in the irrigable area (on the right banks of the Aguan River) are as follows:

Western Part Near Olanchito	:	110 m
Eastern Part near Saba	:	80 m
Near Southern Mountains Foot	:	115 m
Near Northern Mountain Foot	:	75 - 100 m

The water supply volume diverted from the rivers of the Aguan, the Mame and the Jaguaca has been studied by assuming 2, 3, 5, and 10 years return period. As the result of a correlation study between water supply volume and crop yield, a return period of 1 in 5 (1:5) years has been employed as the design criterion for planning irrigation method.

The possibility to irrigate by gravity the surface river water of the Aguan, the Mame and the Jaguaca has been assessed considering irrigable area, water supply requirements and the water discharge of the rivers. This assesment has concluded that the water discharge of the Jaguaca River will not be enough to irrigate the arable area under command and diversion from the Mame River will be required.

Regarding the diversion system from the Aguan River, two intake sites have been proposed instead of constructing one long canal. This proposal has been presented after studying the location of the site for the conveyance canal and topographic conditions. The sites for the construction of the head works have been located at four points (two on the Aguan River, one on the Mame River, one on the Jaguaca River).

On the other hand, irrigation by pumping has been designed for areas where, due to the topographic conditions, irrigation by gravity is not technically feasible. These areas include: the terrace on the right bank of the Aguan River, the terrace on the left bank of the Mame River and the terrace on the right bank of the down stream part of the Aguan River. Pumping stations will be constructed in two sites where damages by inundation will not be anticipated.

4.2.3 Drainage Scheme

A general description of the flood characteristics of the Aguan River is presented in the Master Plan. In the course of the feasibility study, a map of flood damage within the project area has been prepared as the results of a field survey, verbal reports from local farmers and an existing topographic map study. The extent of flooding has been calculated for return periods of 2, 3, 5 and 10 years. The results are as follows: 3,900 ha for 1:2, 5,300 ha for 1:3, 7,000 ha for 1:5, and 7,300 ha for 1:10.

The design criterion for the planning of the drainage method has been established by means of the B/C ratio. The construction of the dyke has been designed with 2-3 meters freeboard on the access road to be constructed along the right bank of the Aguan River and the dyke is expected to alleviate flood damage. A return period of one in five (1:5) years has been employed as the design criterion where the B/C ratio becomes maximum.

Being an extension of the steep sloping area, no canal system has been designed on the left bank area of the Aguan River. In contrast, on the right bank area, existing small tributaries and streams will be improved to be used for drainage canals and, moreover, a drainage canal system to flow directly to the Aguan River has been planned at a density of 1 to 2 km interval. The lay-out of this drainage canal system has been determined after studying the collecting area and the land slope.

4.2.4 In-farm Road Network

There is no notable in-farm road network in the project area except in Sector 5 (between Saba and the Jaguaca River) where nine improved roads had been constructed by INA for the cooperative members of the phase II Lower Aguan Project.

Taking into consideration the farm lots in the future an in-farm road network to link with the Saba-Olanchito main road has been designed at an average interval density of 1 km. Furthermore, one access road will be constructed along the right bank of the Aguan River.

This road has been designed to serve also as a dyke to alleviate flood damage caused by the inundation of the Aguan River.

4.2.5 Cropping Patterns

Of the arable land of 15,800 hectares, approximately 2,600 hectares have limited potential for crops, because they are affected by soils with gley horizon and gravel. The fertile quality of soils in the remaining area of 13,200 hectares would make the production of a wide range of crops technically feasible.

The area with gley horizon soils is recommended for allocation to pasture and paddy fields whereas the area with gravel soils to pastures only. Of the area with fertile soil conditions, a total area of 9,100 hectares will be served by an applied irrigation system necessitating the allocation of crops with high productivity. The balance of the area, 2,000 ha without an irrigation system but with good soil conditions, will be allocated to crops growing well with natural rainfall.

Apart from the agronomical point of view, cropping patterns should be determined considering the prospect of their commercialization in domestic and international markets. The improvement of the balance of payments situation is one of the most important goals for the country now. In this regard, emphasis should be placed on the allocation of substantial areas to export oriented and import substitutional crops. On the other hand, in order to maintain self-sufficiency, allocation to grain crops is also required in view of the high growth rate of the country's population.

The final proposal for cropping patterns has been determined after studying the availability of a labor force and the economic feasibility of crops.

4.2.6 Livestock Production

Livestock production has been a very important activity for the project area. Further development of this sector is anticipated in the future, because with the increase of agricultural production in the area animal feed derived from rejected basic grains, vegetables and fruits will be more economically and easily available.

Exports of dairy products and meats are also envisaged if an improvement of quality in these products is attained through the introduction of better breeds and consolidation of processing plants.

And, the generation of methane gas utilizing pig manure will serve not only for the increase of farmers' income but also for the conservation of the silvicultural resources of the area.

4.2.7 Agriculture Industry

Depending on the allocated area to citrus, the installation of concentrate plant within the project area will be recommended. This type of plant is contemplated for the Integrated Aguan Valley Development, Phase III, so coordination between two projects will be needed.

4.2.8 Dairy and Meat Processing Plant

With the increase of dairy products, the extension of existing three dairy plant situated at the upstream of the Aguan River will be desired. For the introduction of porcine production in the area, meat packing plant in Olanchito should be improved and extended.

4.2.9 Social Infrastructures

Desertion has been reported as a common phenomenon among cooperative members of the Lower Aguan Project. The consolidation of the social infrastructure has been one of the main strategies for the development of rural areas where climatological and social environment present severe conditions.

At least, such indispensable infrastructure elements for the settlement of farmers as houses, schools, health centers and water supply systems the location of which will be indicated in the development plan. The provision and improvement of other facilities like extension and training centers, community centers and a maintenance and storage centers will be examined considering the development level.

4.3 Farm Operation Plan

4.3.1 Land Use and Cropping Patterns

There is an arable land of 15,800 ha between Saba and Olanchito, among which 9,100 ha will be irrigated. Of non-irrigated area of 6,700 ha, 2,300 ha will be allocated to pastures and the remaining 4,400 ha, being located near Saba where the amount of rainfall is relatively large and the soil conditions are good, will be to new crops. Within the irrigated area, there exists the gley horizon of 200 ha in total, in which the cultivation of crops will be limited to rice in primavera season and maize in postrera season.

The principal subsistence crops such as maize, rice, beans have been chosen in this area as main crops. But, it is not desirable to practice extensive agriculture with inexpensive cereals in a small area limited to 5 - 10 ha. When the irrigation system is completed, high yield will be expected with high technology. The profits from such high yields will make it practicable to bring under cultivation the uncleared waste land of the cooperatives.

When a farmer has a fair amount of savings, it would be possible to introduce new crops such as cassava, taros, mango, papaya, pineapple, spices and tomato. These crops would be intended for export, and the cultivated area should be increased gradually. As the quantity of fruits increases, the establishment of a processing factory will be needed.

Cropping patterns are shown in Fig. 4-2. Cultivating maize, rice, beans and vegetable under irrigation, rotation could be extended from 2 crop seasons to 2.5 crop seasons.

The most serious problem in the primavera crop is the high moisture content of the grain, generally around 22%. But if maize is sowed in March and harvested in July as shown in the 6th rotation of Fig. 4-2, the moisture content of grains could be decreased slightly, because rainfall is slight in July.

Further Prospects of new crops is as follows:

(1) Cassava and Taros

Cassava and Taros are exported to Europe or to the United States for sale to the Latin communities in these countries.

(2) Plantains

Plantains are currently produced in the Valley principally for domestic consumption. They are also exported to other Central American countries and the United States.

(3) Pineapple

The principal destination of export is the U.S.A. and Germany. The. U.S. import market for fresh pineapple is estimated at some 70,000 tons, of which Honduras now supplies a half. In addition to being exported fresh, pineapple is juiced as concentrate for export principally to the United States.

(4) Mango

There is an increasing demand for production of juice. Both pure mango juice and mixed tropical fruit juice are intended for the United States market. But export of fresh mangos to the United States would be constrained by phytosanitary restrictions.

(5) Tomato

Tomatos and cucumbers for export were produced by the Standard Fruit Company in the Middle Aguan Valley in the 1970's, but for a

combination of technical and marketing reasons the project was abandoned. The principal marketing problem appears to have been that tomatoes which were only allowed to enter the United States north of the 38 parallel, because of regulations against the Mediterranean fruit fly, failed to arrive at their destination in an acceptable condition.

Since that time, however, a pilot project for production of tomatoes and cucumbers for export has been implemented in the Comayagua Valley and has shown that shipment of tomatoes can reach Northern U.S. ports in good condition. It is necessary to continue investigating the potential of this crop.

(6) Papaya

Papaya is for domestic consumption and is exported to Central America.

(7) Spices

Honduras imports Lps. 1 million of spices such as black pepper, cinnamon, and clove. Cultivation of these crops should be examined to improve the balance of payment.

(8) Soybean

The international market for this product has expanded substantially in recent years, because soybean contains a high percentage of oil and protein. Honduras, like other Central American countries, imports a substantial quantity of oil as well as soybean cake. Although the world market of this product has been dominated by U.S.A. and Brazil, it should be possible to find market outlets either for the local feed industry or at a later stage for the export of soybean oil and cake.

The cultivation of soybean does not require skillful technology and the mechanization can be used easily. In this context, soybean will possibly become an important basic grains for Honduras. For better commercialization in the future, this product requires to be cultivated under the long-term plan and Government guidance including the establishment of an oil-extracting plant would be beneficial.

(9) Cocoa

Cocoa, as well as oranges, is a product whose prospect for export to U.S.A. and European countries is bright. This crop is cultivated preferably in the upland with ground level less than 300 m and with fertile fine textured soils containing pH value more than 5.5. It is more preferable to cultivate it under the climate condition with annual rainfall between 1,500 mm and 2,000 mm and with consistent monthly rainfall. In terms of ground level and soil conditions, the project area satisfies the requirements; the deficit in rainfall will be compensated by the provision of irrigation water. Furthermore, with the introduction of desease proof variety and establishment of cropping technics such as application of fertilizer etc., it is possible to cultivate cocoa in large scale in the project area.

In addition to these, sweet potato, ginger, peanut, apricot, plum, tamarind, sapodilla, loquat, and mangosten are interesting as new crops. However, these crops could be cultivated on a small scale for domestic consumption because they are not expected to be exportable in large quantities.

For the future development of the cropping plan for 9,100 ha of the irrigated area, four cases have been presented in this study as shown in Table 4-1.

In Case 1, a large share of cultivation is allocated to such basic grains as maize, rice and beans. Although it is difficult to estimate the level of the national self-sufficiency in basic grains over recent years in Honduras, it could be presumed by updated information that the national self-sufficiency for rice and maize has almost been attained recently. Nevertheless, in view of the future increase of population and the enterprise for ways of exporting, further expansion of output in these products will be required with the introduction of large-scale cultivation, advanced technology and mechanization. On the other hand, beans, being consistently featured as an export crop, are expected to broaden their potentiality.

Maize and beans are harvested two seasons a year, but rice is cultivated only in the rainy season, because the latter requires intensive labour force for weeding, bird scaring and harvesting. As substitute crops for rice in the dry season, maize and beans are considered. (See Fig. 4-2.)

On 4,400 ha of non-irrigated area, maize, cassava and taro will be cultivated; these get relatively high yields even under non-irrigated soil conditions. Cocoa, mango, orange will also be introduced in the non-irrigated area, because these crops are usually able to get larger net returns than basic grains in such an area.

The cropping plan for non-irrigated area will be the same for the four cases presented. The proposed cultivated area for each crop in the non-irrigated area is shown in Table 4-1 (2).

The proposal for case 2 is to decrease the cultivated area for basic grains and to introduce export-oriented new crops such as cassave, taros, cocoa and papaya. The total cultivated area for new crops will be 2,600 ha and this area, being medium-scale compared with that of 6,500 ha for basic grains, is considered to be appropriate for farmers to carry out cultivation. As indicated in Table 4-2, permanent crops are expected to produce larger net returns than basic grains after they start production of fruits and repay production costs. Furthermore, the benefit from the introduction of the irrigation system will be higher in new crops than in traditional basic grains.

The scenario for Case 3 is to allocate the largest area to the cultivation of cocoa, and to combine this crop with other crops requiring less skillful technology in cultivation. As examples of these crops, soybeans, cassava, taros and plantains have been

selected. The cultivation of oranges require less labor force after production. In this context, the introduction of such a labor-extensive crop as tomato will be feasible. The proposed total cultivated area for new crops will be 4,423 ha, which occupies almost half the share of the total irrigated area. Because the number of new crops is few and the cultivation for these crops requires less skillful technology, this scenario of Case 3 will be an easily acceptable plan for settled farmers. Among new crops, soybean will be used for food, oil extraction materials and feed for animals.

Case 4 proposes to introduce new crops as extensively as possible. The total cultivated area of new crops in this proposal will be 4,723 ha and this area exceeds half the share of the irrigated area in total. The introduction of new crops is recommended to be increased in cultivation area since the market for these crops will increase. In this sense, it is ideal to begin with Case 2 and, after the farmers become accustomed to the cultivation of new crops, gradual transfer to Case 4 is proposed which will easily be accepted. In this scenario, the total area of 4,377 is left for basic grains, which is essential for attaining and maintaining a stable level of income for farmers. The cropping area should be increased in accordance with the advancement of technology among farmers for the cultivation of new crops. Table 4-3 shows a scenario for the staged introduction of new crops in Case 4.

The net return will be the largest in Case 4, whereas the smallest in Case 1. At present, it is recommended that Case 4 or Case 3 be adopted.

4.3.2 Production of Crops

A comparison of the yields of crops in an experimental station and a farmer's field shows that the yield of the latter is one third or one-forth of the yield of the former. This striking difference arises because the farmer uses neither plowing nor fertilizer, pesticides or fungicides. The profit margin of maize, rice and beans is not large, so that, to obtain the maximum benefit from irrigation, particularly in such a well-watered area, it requires that high technology be employed and high yields be obtained. The yield expectation of maize irrigated under high technology might be 5 ton/ha initially which might rise to 7 ton/ha later; the yield of rice could be 4.5 - 5 ton/ha and the yield of beans would rise from 1.5 to 2 ton/ha.

Observing the present state of the cooperatives settled between Saba and Olanchito, the fields were brought under cultivation partly in the days of settlement by farmers and the waste land is as it was without clearance. Half of the cooperatives have pasture without cows, due to the fact that the cooperatives are in financial difficulty. Consequently, when the farmer cultivates the crop in the field, non-ploughing, non-application of fertilizer and insecticide can not be helped. Leaving the matter as it stands now, the farmer is caught in a vicious circle.

Seizing the change of cultivation under irrigation and with high technology, the farmer should make a great progress, and clearance of the fields could be achieved by the investment of the profit earned in a few years, because the cost of clearance is only Lps. 668 per ha. With the completion of clearance of the field crop yields would increased several times over present yields. In that case, the cooperatives would be able to buy the minimum scale machines as shown in the table below. As the farmer saves time due to mechanization, intensive crops such as, tomatoes, cucumber and others could be introduced to cultivation by using the surplus labour and machinery.

Small Scale Machines and Prices

Tractor (74 H.P.)	Lps 40,800
Disc plow	7,845
Disc harrow	7,485
Seeder	10,600
Corn sheller	6,000
Tractor (25 H.P.)	18,000
Cultivator	3,500
Ridger	2,000
Speed sprayer*	35,000

* Speed sprayer will be procured 10 year after the commencement of the Project.

4.3.3 Farm Operation Techniques

(1) Cropping Technics

Cropping techniques to be required for this Project are not, by nature, complex and are commonly practiced in industrialized countries. It is already used by the experimental stations and general agricultural extension services. The chief subjects are as follows:

1) Good preparation of the field
2) Exact planting distance
3) Selection of the improved variety
4) Moderate applications of fertilizer
5) Application of herbicide
6) Application of Insecticide
7) Application of fungicide

(2) Grain Storage

In order to attain optimum moisture content of grains, it is desired to build a grain storage facility with a drier. Two storage facilities have been built already in Olanchito and Tocoa, but a new one is necessary because grain yield in this zone will be increased greatly and the cooperatives in this district could play an active part.

(3) Processing Factory

Now that the construction of the Port of Castilla has been completed and with the realization of the pavement of the connecting road, the Aguan Valley will be recognized as a producing district of fruits and vegetables for export. To facilitate the cultivation of these crops, it is necessary to build a processing factory. Tomato, pineapple and mango might be cultivated to be exported fresh fruits, but on the other hand, processing of these products should be considered to make ketchup or tomato paste and to juice pineapple and mango.

4.3.4 Farmer's Income

The net return of traditional practice for maize is shown in Appendix, Table E-34. In this case, weeds of a field are only cut by machete without ploughing and fertilizing, and herbicide is not applied to maize. Net return is very small. In Appendix, Table E-35 there is semi-improvement sample; in Appendix, Table E-36, an irrigated sample is shown. Net return increased as the degree of cultivation becomes higher.

Similarly, Appendix-Table E-37 and Table E-38 about rice, Table E-39 and Table E-40 about beans show the same conclusion.

Calculating the crop budget of the 24th cooperative (Aguan Caliente) for example, the results are shown in Appendix, Table E-41 (a), (b). The cooperative (45 members) gets only Lps. 70,085 in the traditional cultivation, and each member might receive Lps. 1,557. But in the improved cultivation under irrigation, the cooperative gets net return of Lps. 236,296 and each member could receive Lps. 5,250. The earnings for improved cultivation are three times as large as those produced by traditional methods.

The difference between the two is Lps. 166,205. Cooperative members could use to clear the waste land of the cooperativeas well as to purchase the agricultural machineries.

Entering upon a new phase of mechanization, even if the land newly cleared is added, all the land could be easily cultivated, and benefits would be doubled.

Crop budgets of new crops are shown in Appendix, Tables E-42 thru E-50. Among these perennial crops, the cultivation of orange and mango will require much initial investment cost for 4 or 5 years from planting to harvesting, whereas the cultivation of plantain, cocoa, papaya and pineapple will not be the case, because it takes less time to yield the first crop.

Apart from being costly in initial investment, the interest rate of BANADESA is 13% annually. In order to lighten the burden of high interest rates the cultivation of beans as a catch crop is proposed to cover 60% of fruit field. In view of maintaining the soil capability as long as possible, the catch crops will be limited to leguminous plants and to acontinuous period of 5 years. The surplus of net returns will be realized in early times for such perennial crops as plantain, cocoa, papaya and pineapple, whereas it will take no less than eight years for orange and mango. (See Appendix, Fig. E-4 to E-12).

At the end of the 3rd stage plantation (refer to Table 4-3.), and before paying the initial investment, the net returns of crops in 9,100 ha of irrigated area can be summarized as follows (irrigation cost is excluded from this calculation).

Net Return in 9,100 ha

	Total net return Lps.	Net return in 5 ha Adjudicated area Lps.
Case 1	18,307,388	10,059
Case 2	21,834,395	11,997
Case 3	21,793,393	11,974
Case 4	24,398,193	13,406

4.4 Livestock

4.4.1 Cattle Farming

(1) Introduction and Specialization of Improved Breeds

It is recommended that the cattle breed should be gradually changed from the prevailing Brahman and Criollo to the improved breeds. It is also necessary to promote specialization of a raising breed from the dual purpose breed to a breed specialized in each for milk and meat production. The specialization of a breed has already been developed in the neighbouring provinces such as Atlantida, Colon and Cortes, and it is reported that its productivity is higher than that in the study area. As frozen semen from U.S.A. is now available in Honduras, it will be easy to improve the breed.

(2) Introduction of Legminosae Grass

Only Leucaena, a kind of plant for use as grazing cattle, is presently planted for use as a fence among Legminosae grass. This plant casts its leaves, so it cannot be used as grazing during season. It is necessary to introduce Legminosae grass such as Tropical Kudzu (Pueraria phaseoloides) (ROXB.) var javanica (BENTH. BAK.), Centro (Centrosems pubescens BENTH.), Desmo (Desmodium ovalifolium (PRAIN) WALL. ex RIDLEY). A kind of Legminosae, a same genus of Tropical Kudzu which grows wildly in the area, has been utilized as green manure. Therefore, it can be said that the soils in the project area has enough potentiality to plant Legminosae grass.

Merkeron, a kind of Gramineae, which is often utilized as grazing cattle, grows too high to result in useless some parts. It is recommended to introduce species specialized in low height and many leaves in stalk such as Capricorn. This grass is already planted in several provinces such as Compayagua and Fco. Morazan.

It is possible to increase nutritive valve of pasture and then to obtain good effect for soil improvement through the mixed cultivation of Legminosae and Gramineae.

(3) Rationalization of Raising Practices

One of the most important points to cattle raising is to supply continuous cattle feed during the dry season. In order to achieve this goal, it is necessary to utilize the hay and silage, as well as to introduce the Legminosae grass as above mentioned. As the pasture management is comparatively well conducted in the project area, the utilization of the hay will be easily realized by the introduction of machinery. Apart from this, the employment of feeding system of forage will lead to the utilization of the hay. Furthermore, the raw materials for feeding which is mainly composed of agricultural byproducts such as rich bran, corn bran cake, etc. are easily available and cheap in the country. It can be considered that the effective utilization of these materials

will greatly contribute to the increase of cattle production through improvement of nutritional conditions, increase of calf production, decrease of mortality rate of calves, and procurement of substitute feed during the dry season. In order to prevent the appearance of mastitis which cattle farms of the area are confronted with, it is recommended that the cows be milked twice a day as one of the countermeasures.

Through the introduction of the improved breeds, the utilization of Legminosae grass and the rationalization of raising practices, the increase of productivity can be expected.

4.4.2 Introduction of Pig Farming on a Commercial Base

As described in the Section 3.7.6, the domestic prices of pork and its derivatives are very high in Honduras. Thus, it can be assumed that the potential demand for pork is large. It is also said that pork is consumed less than beef in the country. The following two points are considered as the main reasons for this situation.

(1) The improved breeds are not reared much and pork production is extremely low.

(2) Criollo is mainly reared under traditional ultra-extensive method, which often causes parasites in products followed by inferior quality and a bad reputation.

Considering these points, it is recommended to introduce improved pig breeds and to change raising practices from an ultra-extensive one to pasturage or confinement.

In the study area, the development of pig farming, especially by medium and small-scale farmers, will be preferrable for the following reasons:

(1) By-products for feeding pigs derived from such agricultural-products as rice, maize, banana, plam-oil are easily available.

(2) The climate in the area presents no limitation for raising pigs.

(3) With the implementation of a new pig farming project, the interest for raising pigs among local farmers has gradually been rising.

Furthermore, pig raising does not require neither skillful management nor much capital investment. Upon the provision of proper technical assistance and disease control, therefore, the development of pig farming in the survey area will largely contribute to the upgrading of income level and the improvement of the nutritional conditions of farmers. These will be supported by the adequate commercialization of pork and its derivatives as special products of this area. At present, there is no good example of pig farming development in the country.

4.4.3 Introduction of Layer Chicken Farming on a Commercial Base

The layer chicken is also a prospective field of livestock, next to pig farming. As in the case of pork, chicken eggs are comparatively expensive all the year round, and the demand in the domestic market is expanding. Apart from this, it is possible to sell eggs to the market directly without the intervention of retailers unlike the marketing channel of meats. Furthermore, it is not so difficult for even old people, women and/or children to manage chicken raising. The raw materials for chicken feed are also abundant in the country.

The broiler is presently raised at modern type large-scale farms in San Pedro Sula and Comayagua, and its frozen products have already been found in Olanchito. It is not encouraged to raise broiler in the project area, because as the transport infrastructure will be improved, more broilers will be brought into the area. On the contrary, most of the chicken eggs are sold without being washed and selected even at the major consumption areas such as La Ceiba, San Pero Sula and Tegucigalpa. The layer chicken raising will, therefore, be a prospective for future development of the area.

4.4.4 Introduction of Freshwater Fish Culture

The freshwater fish culture has already commenced in other areas of the country. Tilapia and carp are cultured under private business in Coyoles and under the cooperative's women group's project in Cholomena.

Besides, the integrated agricultural project introducing pig and tilapia production is now under implementation in Carcal, Colon province. As described in Section 3.7.6, the price of freshwater fish is relatively high compared with other foodstuffs, and its demand is also high. It is possible to conduct freshwater fish culture at water impoundments and river side in the project area. As with pig and chicken raising, freshwater fish culture does not require skillful management, and its feed can also be provided with utilization of agricultural byproducts.

Integrated farming with pig raising, which has widely been experienced in Southeast Asian countries, is one of the most suitable culture systems in developing countries. The advantages of this integrated farming are:

(1) that animal feces can partly be utilized as feed for fish; and

(2) that the waste part of fish can be utilized as raw materials for feed for livestock animals, particularly as an important source of protein supply.

The fingerlings (F1) of tilapia can be obtained at the national hatchery in Comayagua. However, the areas for this integrated farmings should be limited to some special zones in order to avoid the overproduction of freshwater fish.

4.4.5 Utilization of Methane Gas

The reason why the raising of pigs and chickens is recommended is that the feces derived from these animals can be converted to methane gas and thus be utilized as fuel for cooking. At present, charcoal is principally used by most of households even in the urban area of Olanchito, and firewood is used in rural area. Being dependent on wood as main source for energy, the conservation of forestal resources has been ignored in the country. The over-exploitation of forestal resources could badly influence flood control in the Aguan River Basin.

In the tropical region, the utilization of methane gas is possible all year round with less investment for facilities and operational costs. It may also be possible to treat the human feces of rural people with this method, if necessary. In view of flood control, forest conservation and public sanitation of the regional society, it is of great importance to avoid over-exploitation of the forests by substituting less costly energy source for wood fuel.

4.4.6 Utilization of Animal Feces at Manure

There is a remarkable lack of vegetables in the project area including Olanchito. The feces of pig and chicken are highly effective as manure, so that it will be possible to promote the cultivation of vegetables by utilizing them as compost or dried chicken feces for soil fertilization. It is easy to make compost by mixing with abundant wild weeds and sawdust which is a byproduct from the sawmill. Furthermore, the surplus of compost and chicken manure can be utilized for fertilizing other agricultural corps and pasture.

4.4.7 Establishment of Systematic Extension Service and Animal Disease Control

It is essential to establish and develop livestock farming of small-sized animals including freshwater fish culture to provide appropriate extension and guidance, as a prerequisite to a successful operation. As a matter of fact, the new "Pig and Poultry Project" being realized in the project area presents a low-production level due to the insufficient provision of technical assistance and extension services to farmers although the improved pig breed is introduced.

Many farmers, particularly those of medium and small-scale, in the project area have shown a strong interest in the introduction of new livestock technology, while they require skillful management. Therefore, it is expected that livestock development in this country will be achieved through the improvement and establishment of systematic technical assistance and extension services.

4.4.8 New Livestock Processing Facilities

(1) Cattle Raising

Upon the improvement of infrasturcture, it is envisaged that the LEYDE will expand milk collection by more practical methods. In this context, the strengthing of existing cheese plants (treatment of milk, diversification of products, improvement of quality control etc.) will be recommended; installation of new plant will not be considered since this should compete with LEYDE's.

(2) Pig Raising

If the number of pigs raised will be increased, it will be necessary to improve and expand the slaughterhouse in Olanchito. Pork processing products such as ham, bacon and sausage are prospective. It is, therefore, recommended to produce these pork products by improvement of the afore-mentioned cheese plant which is presently operated only in the morning. Each of the existing cheese plants occupies a wide area and a small-scale smoke house. In addition, there is the possibility of developing pig raising by feeding them whey from cheese production. Pork products, as well as cheese, can be processed without a complicated production line and specific machinery. It is expected that the effective utilization of this plant will contribute to the raising of the supplement value of pork.

(3) Feed Plant

In order to raise small-sized animals (including freshwater fish), enriched feed will be essential. As mentioned before, raw materials for feed will easily be available in the area, so the establishment of the simple feed plant capable of producing formulated feed will be recommended. It is desirable to produce the formulated enriched feed (concentrate) which can be mixed with available agricultural byproducts at farms.

This feed plant will be expected to supply feed covering all the Aguan River Basin, by gradually expanding its capacity in accordance with development status of animal raising. At present, the feed plant exists only in San Pedro Sula. The proposed feed plant is also expected to produce formulated feed for cattle, so as to contribute to the increase of beef and milk production in future. By establishing the feed plant, the farmers producing cereal will be able to sell their unused products to the feed plant. In this point of view, the establishment of a feed plant will be effective and will contribute to stable farm management of small-sized animals.

(4) Pig Breeding Station and Fish Hatchery

In order to introduce pig raising and freshwater fish culture on a commercial basis into the project area, the supply of breeding pigs and fish fingerlings will be important. Presently, breeding pigs and fish fingerlings are supplied from the Pan American Agriculture School in Samurano and from the national hatchery in

Comayagna, respectively. However, both breeding pigs and fish fingerlings have to be delivered over a long distance, suffering occasional accidents during transportation. In order to accelerate practical extension of these a pig breeding station and fish hatchery should also be established in the project area. This will contribute to the development of new livestock and aquaculture, and will give great vitality to agricultural production.

4.5 Irrigation and Drainage Plan

4.5.1 Irrigation System

(1) Basic Concept

1) Water Resources for Irrigation System

The water resources for irrigation purposes must be decided at the initial stage for the planning of the irrigation system. The first task is to consider how the water will be captured readily and economically. In this sense, emphasis should be given to the utilization of the surface water as the sources for the irrigation water. Where the riverbed is composed of fine gravel, surface water will not be secured and in that case, the underflow water must be considered for water resources.

Occasionally, it is not feasible technically and economically to get the river water in the basin of heights or plateaus. In that case, the potentiality of ground water as the irrigation water resources be surveyed. As the result of the groundwater survey, it was disclosed that the volume of the available underground water is limited to 500 - 2,000 m^3/day even in sufficient reserve zones. Therefore, it is not feasible to utilize underground water as the systematic irrigation water resources.

In the project area, it has been confirmed as a result of hydrology and water requirement studies that the surface water is sufficient to irrigate even in drought season. Consequently, only the surface water is considered as water resources for the irrigation scheme.

At present, no specific customs of water use is established in the Aguan River Basin. The irrigation system is practiced at the banana plantation of Isletas and Coyoles. On the other hand, irrigation water for Phase I & II Lower Aguan Project is not diverted from the Aguan River but pumped from shallow wells.

In view of securing river surface water to the Isletas banana plantetion, the influence of the implementation of this project has been assessed in the following manner.

The river discharge of the Aguan at Pte. Saba in drought period is calculated to be 19.8 m^3 for the return period of 1/5. In this

case, the maximum water requirement to be used for irrigation works of the project will be 2.0 m^3/s; the balance of 17.8 m^3/s will be available for the irrigation of Isletas banana plantation. The maximum water requirement for banana plantation is estimated to be 2.6 m^3/s, which count for only 15% of available river discharge of the Aguan.

From the above assessment, it has been concluded that the irrigation scheme for the project will have a minor effect on the water resources of the Lower Aguan Basin.

2) Intake Points

To facilitate diversion of water by gravity, it is dessirable that the intake point be located as high as possible.

In case of the middle Aguan Valley, the installation of head works in the upper stream of Pte. Olanchito is not recommended due to the follwoing reasons:

(1) There is a mountain close to the right bank of the Aguan River and some land slip can be observed.

(2) The banana plantation is located in the area proposed to the installation of conveyance canal.

(3) The incline of the river is so gentle as to be 1:1,250.

If a head work should be installed in the upper stream of the Pte. Olanchito, there will be no alternative but to design a canal with great flow in the mountain side and to install a long canal crossing banana plantation where is already equipped with complete irrigation and drinage canal network. Consequently, this alternative will not be feasible from the viewpoint of cost saving.

On the other hand, the banana plantation is a private property of the Standard Fruits Co. and is equipped with its own intake works. Therefore, problems with water rights will occur.

The two different alternatives have been studied for intake point; locating at Pte. Olanchito in the ulmost upper Aguan; viz:

Plan 1: To intake the irrigation water from one intake point (Refer to Fig. 4-3)

Plan 2: To intake the irrigation water from several intake points (Refer to Fig. 4-4)

In Plan 1, the mean discharge of the Aguan River at Pte. Olanchito, is 10.8 m^3/s in dry season. With this volume, approximately 12,000 ha can be irrigated, locating one intake point at the upper part of the irrigated area in view of the rationalized control of the water division. However, the irrigable area is 4,700 ha, which is smaller than Plan 2 due to the restriction of the topographical conditions and headwater level, as explained in Fig. 4-3.

In order to concentrate the intake point, the main canal becomes inevitably large and long. In this case, more water will be lost during the conveyance; furthermore incidental facilities, such as syphons, protection of cliffy place etc. must be constructed. Operation and maintenance will be more difficult and the construction works will be more costly compared with Plan 2.

On the other hand, judging from the results of the topographical and hydrological studies, it becomes clear that it is the most feasible plan to locate four intake points in this Project Area. See Section 4.5.1 (3). The locations of these intake points have been selected as i) Upper Aguan, ii) Middle Aguan, iii) Mame River and iv) Jaguace River (See Fig. 4-4.

In Plan 2, the irrigable area is 6,220 ha, and it is more economical, because the structure of each facilities are small in size and no other facilities like syphons will be required, though the intake works increase in number.

As a result of the above study, it has been concluded that Plan 2 is more feasible technically as well as economically.

3) Supplying System

For the supplying of irrigation water, two systems are studied apart from Plan 2, in view of the necessity to increase the irrigable area by means of pumping. Two pumping stations are considered to be in the Aguan River, no other rivers having water availability in the drought season.

The following are two systems presented:

Plan 3: Pumping to the middle plateau (Refer to Fig. 4-5).

Plan 4: Pumping to the higher area (Refer to Fig. 4-6).

The pumping structure for Plan 3 will be smaller than Plan 4 ($Q=0.4$ & 2.1 m^3/s, $H=7$ & 22 m). The irrigable area is 9,100 ha but the ratio between benefit (crop yield) and cost (construction of failities) becomes maximum, which means that this Plan is the most feasible plan.

Plan 4 is considered to increase the irrigable areas as much as possible. In this Plan, the irrigable area will be 10,000 ha but the structure of pumping station and water conveyance canal become larger. ($Q=0.9$ & 2.5 m^3/s, $H=25$ & 25 m). This system will not be recommended from the view point of benefit and cost ratio.

The results of the comparative study of each of aforementioned each Plan are presented below.

WATER INTAKE SYSTEM

	Plan 1	Plan 2	Plan 3	Plan 4
No. of Intake Site	1	4	4	4
Scale of Pump Station	-	-	Q=0.4 Q=2.1m^3/s H=7.0 H=22.0m	Q=0.9 Q=2.5m^3/s H=25.0 H=25.0m
Irrigable Area	7,700 ha	6,220 ha	9,100 ha	10,000 ha
Cost	x 1,000 Lps 92,800	96,838	109,735	122,325
Benefit	112,705	124,675	148,112	158,588
B - C	x 1,000 Lps 19,905	27,837	38,377	36,263
B / C	1.21	1.29	1.35	1.30

In employing Plan 3, the two alternatives can be considered as presented below, considering more efficient control of water according to the growing stage of crops and rainfall conditions.

Plan 3-1: To divide into several pumping stations

Plan 3-2: To arrange the farm-ponds at each division point from the main canal in one pumping station

It is clear that Plan 3-1 will be more costly in construction, operation and maintenance. In contrast with this method in Plan 3-2, it is possible to control the water use more economically and easily.

From the above-mentioned considerations, it can be concluded that Plan 3-2, depending only on surface water diverted from four intake points with the additional installation of two pumping stations and farm-ponds, is the most feasible system in planning an irrigation scheme for this project.

4) Irrigation Method

In general, the following methods are considered as the upland irrigation systems.

Surface Irrigation:
- i) furrow irrigation
- ii) border irrigation
- iii) basin irrigation
- iv) drip irrigation

Spray irrigation — v) Sprinkler irrigation
vi) perforated pipe irrigation

Underground Irrigation: viii) sub-irrigation

The irrigation method must be decided by considering the natural conditions (topography, soil, hydrology etc.), management system, capital investment for irrigation system or land reclamation, labor force availability, level of skill for operation etc.

As one of the basic objectives of this project is the agricultural infrastructure development for new settlers, methods iv), v) and vi), which are more costly and require considerable skill for operation and maintenance, will not be suitable at the initial stage of development.

These methods can be applied when the accumulation of capital and advanced level of technology for crop cultivation will be realized by settlers.

Methods ii), iii) and vii) are not suitable to the objective of this project, because they require much construction costs and a high level of technology for land reclamation and preparation.

Considering these aspects, furrow irrigation is considered to be the most appropriate irrigation method; this has also been confirmed by means of the field intake rate test applied to typical soil profiles of the project area (See Table 4-4).

(2) The Flow of the Study

The design criteria of the most effective water supply have been studied from the economical and technical point of view. The flow of the study is shown in Fig. 4-7.

(3) Intake System

In this section the technical possibility of the intake system is described considering the individual characteristics of the eight blocks which have been divided according to topographic conditions and water resources. (See Fig. 4-8.)

BLOCK A: Except the tableland of south, there is 1,780 ha of irrigable land in this block. This area has the same slope as along the Aguan River and therefore it is necessary to intake water by pumping or to locate intake point 1 km above Pte Olanchito for the efficient functioning of the canal system.

Furthermore, from the results of geological investigation, the construction of collecting conduit will not be expected.

Therefore in this block it is necessary that the diversion system be divided into two type as follows:

1) The gravitational intake using head works for 1,300 ha of irrigable land.

2) The pumping up system for 480 ha of irrigable land.

BLOCK B: This block covers the left bank area of the Mame River from the Pte. Mame to the lower area. As an intake system, the following two proposals are considered:

1) To construct head works independently at the Pte. Saba.

2) To intake water from the head works to be located in Block C and to distribute water crossing the Mame River by syphon

Generally speaking, the structure to be considered at the river crossing point will be syphon or aqueduct. In this block, due to the height of the proposed canal site, the latter must be constructed in lower level ground and, which makes the facility faced with the danger to be damaged by the drifting woods in flood. In this sense, the construction of aqueduct is not recommended in this block.

The result of comparison study between syphon and head works is set out below.

Comparison of Syphon and Head Works

Structure		Syphon	Head Work
Irrigable Area		530 ha	470 ha
Construction Cost		Lps. 521,500	Lps. 971,000
Operation and Maintenance	Removal of sludge and Cleaning of intake Point	To be carried out all of these works in one head works to be installed at the upper stream	Required to carry out at each head works.

The above table concludes that the proposal to construct syphon is more appropriate plan.

Due to the topographical condition of this block, the diversion from pumping is not suitable in increasing the irrigable area; diversion from gravity has been employed.

BLOCK C : This block is located in the tableland between the Mame River and the Jaguaca River with 1,850 ha of irrigable land. River water will be diverted from the Mame River and distributed through the canal to be constructed on the right bank of the Aguan River. In order to alleviate damages from proposed flood, such maintenance practices as lining of canal etc. will be required. The diversion from pumping is also technically feasible at the point near Pte. Mame, but the gravity system will have the priority.

BLOCK D : This block is located on the right bank of the Aguan River between the Jaguaca River and Saba where features less difference in ground level.

The gravitational intake by means of head works will be utilized for 1,970 ha of irrigable land; furthermore, another 2,400 ha will be irrigated by pumping up. Irrigation supply will be 3.9 m^3/sec. The intake point must be studied considering the existing and future meandering condition of the Aguan River. In view of the necessity to take into a large quantity of water, fixed diversion weir is recommended.

BLOCK E : This block is located on the right bank of the Jaquaca River with 570 ha of irrigable land. In the dry season, the surface water of the Jaquaca River is not sufficient for irrigating this block, but the installation of a collecting conduit is not suitable considering the geological conditions of this area. Therefore, the lack of water will be supplied from the Mame River utilizing the main canal of Block D.

BLOCK F : This block is located on the left bank of the Monga River. The basin of which is not sufficiently large for the water resources of this block.

In this area, because rainfall is abundant, no irrigation system will be considered.

BLOCK G : This block is located in the Uchapa River Basin. Urban area of Olanchito is located in the upper part of this block utilizing the surface water of the Uchapa River for domestic-use.

In the dry season, the water of the Uchapa River has not been sufficient for the domestic-use. Therefore, the Uchapa River is not expected to be used as water resource for the irrigation of this block.

The thick layer for potential of groundwater makes it feasible to use the ground water resources for supplementary irrigation water. But other conditions, for example land-use and soil, prevent this block from introducing irrigation facilities.

BLOCK H : This block is located in the Uyuca River Basin which is the largest piece of land on the left bank of the Aguan River.

Considering the topographic conditions of this area a gravitational intake without head works will be the most suitable. But given the limited irrigable area, in comparison with the length of canal, only the little benefit from the provision of irrigation system will be expected.

(4) Projected Irrigation Area

Of the aforementioned 8 blocks, the following 5 blocks have been selected as areas where irrigation system will be applied. For the selection of irrigable area, such conditions as soil, topography and availability of water for irrigation purpose have been taken into account. (See Fig. 4-9.)

Projected Irrigable Area

Block	Intake by Gravity	Intake by Pump	Total
A	1,300	480	1,780 ha
B	530*	--	530
C	1,850	--	1,850
D	1,970	2,400	4,370
E	570	--	570
Total	6,220	2,880	9,100

* Distribute water from the main canal of C Block.

(5) Irrigation Water Requirements

1) General Consideration

The water requirements for field irrigation have been estimated on the basis of the proposed cropping pattern.

The following procedures have been employed:

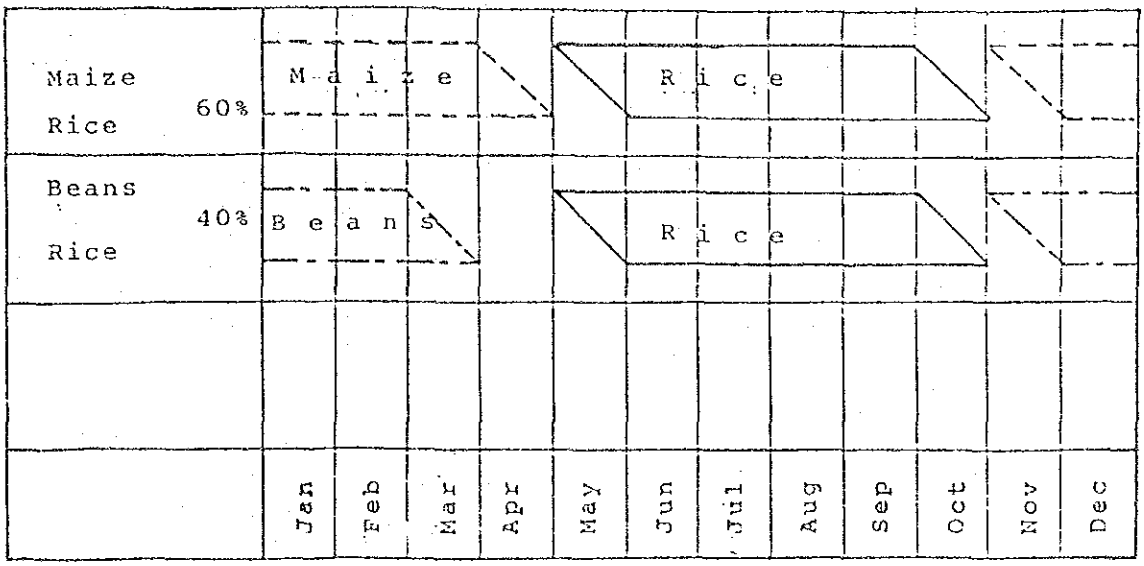
* Identification of proposed cropping pattern
* Estimation of crop water requirements (ET crop)
* Estimation of effective rainfall (Pe)
* Estimation of irrigation requirements

It is noted that the estimation is calculated monthly.

2) Cropping Pattern Model

In order to estimate the water requirements, rice, maize and beans have been identified as proposed crops. This is because these might be basic crops to be introduced at the beginning or in the future of the development of this project. It should be noted that rice requires relatively more water.

A cropping pattern model has been assumed as shown in the following figure.



Schematic Cropping Patterns

N.B.

1st Crop		2nd Crop	
Rice	-	Maize	--- 60%
Rice	-	Beans	--- 40%

Total:

Rice	100%
Maize	60%
Beans	40%
	200%

3) Crop Water Requirements (ET crop)

Crop Water Requirements (ET crop) have been estimated on the basis of reference to potential evapotranspiration (ETo) and crop coefficient (Kc).

1. Potential Evapotranspiration (ETo)

In the Master Plan, based on the climatic record for Olanchito evapotranspiration (ETo) was estimated by three alternative method of Class A Pan, Hargreaves and Samani and Blaney Criddle. In this Feasibility Study, apart from these three methods, Penman method has been added also for estimation of ETo. As a result, the average of all (four) methods has been used for a monthly ETo pattern. And 10 years ETo also has been estimated by month using the Hergreaves and Samani method and has been analyzed probabilistically.

The results are shown in Fig. 4-10 and Appendix Table F-II-1 to F-II-3 and Fig. F-II-2.

2. Crop Coefficient (Kc)

Considering the development stage for each crop, coefficient (Kc) were assumed. For this assumption "Guidelines for Predicting Crop Water Requirements" (FAO 1977) was referred to.

The assumed "Kc" is shown in Appendix, Fig. F-II-3 to Fig. F-II-5.

3. Crop Water Requirements (ET crop)

Crop Water Requirements have been calculated by the following formula:

$$ET\ crop\ (i) = ETo\ (i) \times \Sigma\ [\alpha\ (i, n) \times Kc\ (i, n)]$$

Where,

ET crop (i) : Crop water requirements in a month "i" (mm/month)

ETo (i) : Potential Evapotranspiration in month "i" (mm/month)

α (i, n) : Share of area of crop "n" in month "i"
Ex. α (1, maize) = 0.6
α (1, Beans) = 0.4

Kc (i, n) : Crop coefficient of crop "n" in month "i"

4) Design Rainfall and Effective Rainfall

The monthly distribution of rainfall has been estimated using an eleven years average of each month, based on data for Olanchito. Rainfall was analyzed probabilistically by the Weibull Method, based on annual rainfall. The drought effective rainfall for 2, 3, 5 and 10 years return periods has been estimated.

The drought effective rainfall was estimated by the method employed by U.S. Bureau of Reclamation. The detail of analysis is described in 3.2.3; Table F-II-8 & F-II-9 and Fig. F-II-6 & F-II-7 of Appendix show the design rainfall.

5) Irrigation Water Requirements

1. Net irrigation Water Requirements (q net)

Net irrigation water requirements have been calculated by deducting effective rainfall from the crop water requirements.

Consequently, the maximum net water requirements have been estimated at from 77.8 to 92.5 mm/month in March for the 2 to 10 years return period. Table F-II-10 of Appendix shows the monthly net water requirements in each return period.

2. Gross Water Requirements

Gross Water Requirements have been estimated by dividing the net irrigation water requirements by overall irrigation efficiency, which has been made referring to the FAO guide. Each efficiency has been determined as below:

Conveyance efficiency (Ec)	: Ratio between water received at inlet to a block of fields and that released to the project head works; assumed as 0.8.
Field canal efficiency (Ef)	: Ratio between water received at the field inlet and that received at inlet of the block of fields; assumed as 0.8.
Field application efficiency (Ea)	: Ratio between water directly available to the crop and that received at the field inlet; assumed as 0.6.

So, project efficiency (Ep) becomes 0.38 (Ep = Ec x Ef x Ea).

The maximum gross water requirements of each block have been calculated by the following formula:

$$Q = 3.858 \times 10^{-6} \times A \times qnet/Ep$$

Where,

Q	: Gross water requirements (m^3/sec)
A	: Irrigated area (ha)
qnet	: Net water requirement (mm/month)
Ep	: Project efficiency (0.38)

Each block water requirement is shown in Table 4-5.

(6) River Discharge for Drought

Based on the probability of the mean annual run off, the mean annual runoff for drought design for 2, 3, 5 and 10 years return periods was estimated at Pte. Saba. The discharge of each intake point was estimated based upon discharge at Pte. Saba. Detail is

described in section 3.2.3 "Hydrology". The mean monthly runoff at Pt. Saba for a 2 years return period is shown in Appendix Fig. F-II-8 and river discharge at each intake point for a 2 to 10 years return period in Table 4-6.

River discharge might be compared with irrigation water requirements for examining the availability of superficial river water. At the Jaguace intake point, river discharge has been insufficient in March. However, the discharge at the Mame has been sufficient even if it to be included into the Jaguaca irrigation area. So, the irrigation water resources could depend on river discharge only.

(7) Economical Water Supply

Generally speaking, the crop yield will increase as water supply volume increases, but the rate of increase will decrease when the water supply is at certain point. It has been assumed that the water supply is equal to the net irrigation water requirement and that the crop yield decrease in proportion to the insufficiency of water supply for the target.

On the basis of what was mentioned before, the most effective water supply has been studied as below. The net return can be calculated by the following formula:

$$i = a.y - (e.y + b + c.x)$$

$$= (a-e)\cdot y - b - c.x = F(x) \quad \text{---------- (i)}$$

Where;
- i : Net return (Lps/ha/year)
- a : Market Price (Lps/ton)
- y : Crop yield (ton/ha)
- e : Cost varied in proportion to yield (Lps/ton)
- b : Cost varied in proportion to crop area (Lps/ha)
- c : Cost of water (Lps/m^3)
- x : Volume of irrigation water (m^3/year) (Net irrigation water requirement)

The volume of the most economical water supply can be found at a point of inflection of the formula F(x).

This inflection point can be calculated by the following differential equation.

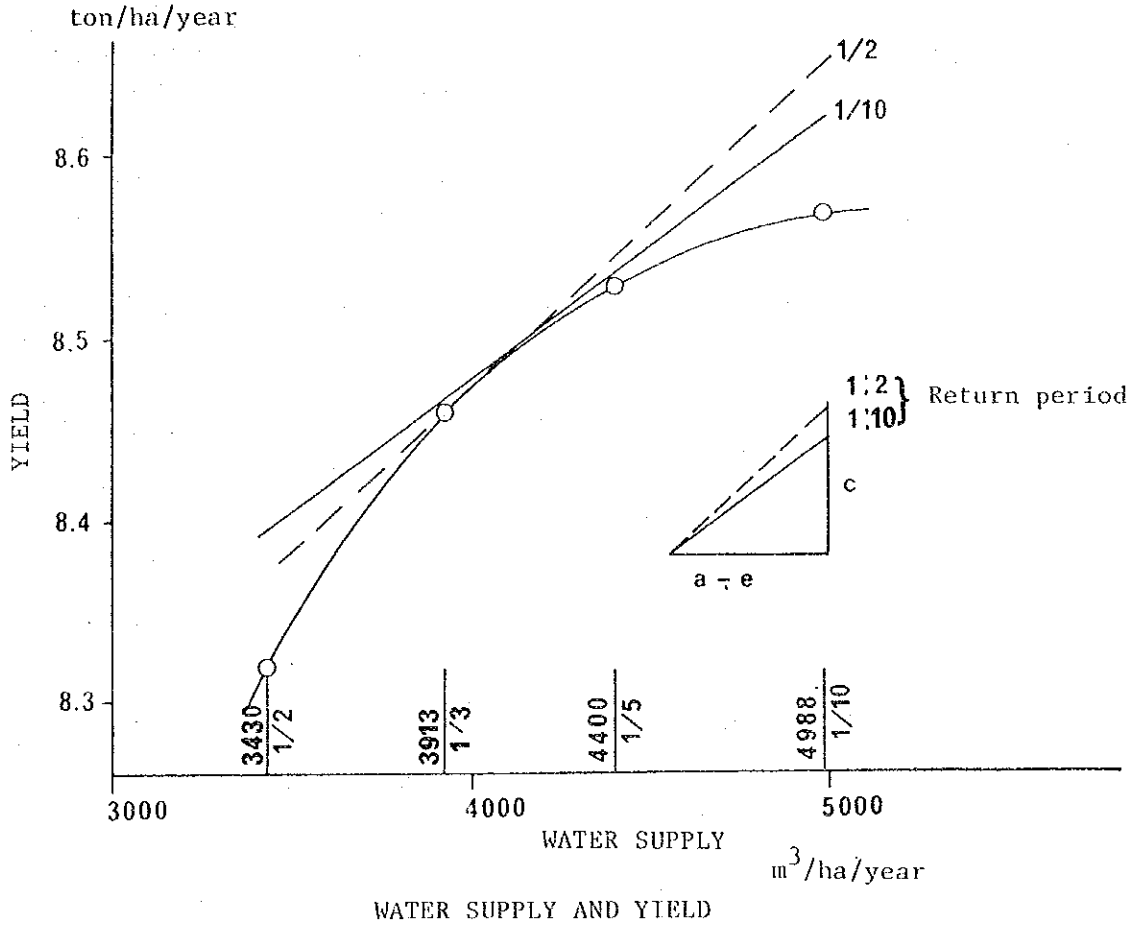
Given: $F(x)\cdot dx = 0$

Calculation: $F(x)\,dx = \frac{di}{dx} = (a-e)\frac{dy}{dx} - C = 0$

$$\therefore \frac{dy}{dx} = \frac{c\ (ton/m^3)}{a-e} \quad \text{----------(iii)}$$

The point of inflection is a point of contact curve F(x) and line whose slope is c/(a-e).

As a result of the study, the most economical water supply has been estimated as 4,100 _ 4,200 m^3/ha/year, that is for a 3 to 5 years return period. Considering that the construction cost was similar (the difference is only 1 -2%), the design year has been decided as 1 in 5 years return period. The relation between water supply and yield is shown in figure below.



WATER SUPPLY AND YIELD

4.5.2 Drainage System

(1) Planning Criteria

The drainage system is to be planned so that it would function economically and effectively together with the irrigation system, which is planned to be installed by utilizing the existing canal.

In right bank area of the Aguan River consists mainly of the flat land with a slope less than 1% to the Aguan River, and has some terraces with a height of 10 to 20 m. The existing drainage system functions well except for the area between Saba and the Jaguaca River.

In the area between the Aguan River and the Mame, where the terrace land expands near the Aguan River, the existing drainage ditches flow down to the alluvial plain parallel with the Aguan River, eroding the slopes of the terrace. In this area, the drainage system will be provided only for the domestic use of the villagers on the terrace land, and no system will be considered in the pasture land and dry land because of good drainability.

On the alluvial plain along the Aguan River, where the new irrigation system will be provided, and because the land is rather flat with a gentle slope of 1 by 1,000, new drainage system should be considered.

In the area between the Mame River and the Jaguaca River also, the terrace land extends to the same extent as that between the Aguan River and the Mame River. Generally, the drainage system is not so dense in this area; some water stagnation is found near Maloa. In order to drain the rainwater immediately, the new drainage canals connecting to the existing small tributaries will be provided.

On the terrace land under irrigation, there will be provided with the drainage system. Nevertheless the existing tributaries will be utilized as much as possible and new drainage system will be constructed only to connect with existing system.

In the lower area of the Jaguaca River, the drainage system is so poor as to depend on only the existing tributaries and some water stagnation is found. It is necessary to establish the overall drainage plan together with the irrigation plan in order to increase land productivity.

Because the Aguan River flows along the left side of the Aguan Valley, neither water stagnation nor inundation is found on the left bank of the Aguan River. In this zone, the rainwater is drained smoothly to the Aguan River owing to the large section of the tributaries and steep slop of the land

The Uchapa River and the Uyuca River play a main role in drainage on the left bank of the Aguan River. The majority of catchment area of these rivers are extended on the hinterland, and most of rainwater is drained with the small tributaries of the Aguan River. Therefore, the drainage plan for this area will be established with an emphasis on the improvement of the small tributaries of the Aguan River of which catchment areas and discharge are ranging from 0.5 to 1.0 km^2 and from 2.2 to 4.4 m^3/sec, respectively. Since the cross section of these tributaries are enough to drain the rainwater as they are, it is proposed to provide culvert structures on the existing road along the Aguan River.

(2) The Flow of the Study

The design year of the drainage plan must be decided considering the cost and benefit of the dyke for flood alleviation. The flow chart of the study is shown in Fig. 4-11.

1) The Extent of Flooding Area

The extent of flooding depends on the scale of the flood. In accordance with the topographic condition of the project area, the flood stage and area for 2, 3, 5 and 10 years of return period have been estimated by utilizing the results of the hydrorological analysis as described in section 3.2.3.

The result of this estimation is shown in Table 4-7 and confirmed by verbal investigation (Refer to Fig. S-6).

2) Basic Considerations on Flood Alleviation

Given flood damage to the Lower Aguan, a flood alleviation plan has been considered as follows:

1. The inundation of 24 hours is permitted.

2. The prevention of crops from being swept away by flooding is considered.

3. The dyke will be constructed so that it would also be utilized as the main access road in the project area.

3) Establishment of the Design Year

The design year has been established based on the relation between cost (C: Construction of dyke) and benefit (B: Alleviation of flood damage). The benefit and cost for 2, 3, 5 and 10 years return periods have been calculated utilizing equations as follows:

1. Calculation of Expected Benefit by Construction of Dyke

a. $Li = Ai \times Pc \times Ci$

Where:

Li: Assumed damage of flood for the probability i

Ai: Flood area for the probability i

Pc: Market price of crop (rice: 2,420 Lps/ha)

Ci: Percentage of damage for probability i (%)

b. $$Bk = \sum_{i=1}^{K} \left[N(i-1) - N(i). \times \frac{L(i-1) + L(i)}{2} \right]$$

Bk: Flood alleviation for the return period 1/K

Ni: Probability i (=1/K)

2. Estimation of Construction Cost

Given the section of dyke as shown in Fig. 4-12, the construction cost of dyke for each return period has been assumed in accordance with topographic condition, water level in inundation and freeboard level of 60 cm. The result of this estimation is shown in Appendix, Table F-II-11.

3. B/C Ratio

The relation between Cost & Benefit and Flood Discharge is shown in Fig. 4-13 and B/C ratio in Fig. 4-14. As a result of cost-benefit analysis, the B/C ratio becomes the highest value when 1 in 5 years return period is applied. In this context, the design year has been established as 1 in 5 years return period (refer to Table 4-8).

4.6 Land Preparation and Farm Land Development PLans

4.6.1 Land Preparation

Considering that the project area presents plains with uniformly mild slope in general, the land preparation works will be carried out only for the depresion and some rivulets which will not be used as drainage canals. These areas will be reclaimed after being drained.

4.6.2 Farm Land Development

The farm land where agricultural machinery will be applied has been designed with the following considerations.

Generally speaking, a length of 200 m - 500 m for the long side of a farm lot is considered to be more appropriate for the farm land in which the transportation of crops to the nearest access road is required. The existing road network between the Jaguaca River and Saba is laid out at the interval of 1,500 - 2,000 m which suggests that the interval of 1,000 m will be reasonable for the road network planning for this project.

On the other hand, taking into account of the prevailing land slope (1%) and conservation of soils the distance for the short side has been proposed as 100 m. According to the standards of the FAO, the distance required for farm land with a slope between 4° and 6° will be 91 m. The size of farm lot prepared by INA for the settlers of agrarian reform is 5 ha. As a result, the standard farm lot has been set out as 500 m x 100 m (see Fig. 4-15).

4.6.3 In-Farm Road

The in-farm road network will be laid out in accordance with farm lot in irrigated area. In non-irrigated area, the interval of each neighboring road will be determined by the actual land use practice.

In-farm road network is consolidated between the Jaguaca River and the Monga River for the cultivation of crops among cooperative members of Sector 5.

For the purpose of efficient utilization of land in the project area, in-farm roads linking with the Olanchito-Saba main road has been designed considering the prevailing the development conditions and farm lots (see Figs. 4-16 and 4-17).

One access road along the right bank of the Aguan River has been designed to serve also as a dyke to prevent the crops from being damaged due to inundation for the 5 years return period. No bridge will be considered on the right bank of the Aguan River at the crossing section of the access road with the Mame River and the Jaguaca River, because the access road has been designed only

to link the Olanchito-Saba main road with farm land.
No in-farm road will be considered on the left bank of the Aguan River but the existing access road will be improved and the three submerged roads (at Uchapa and Uyuca Rivers and Quebrada el Terreno) will be newly constructed.

4.7 Facility PLan

Main structures to be constructed in this project are as follows:

(1) Irrigation System

Head works, pump station, main and secondary canals are included in irrigation system. Tractor passage for farm pond and farm land has been designed as ancillary works of secondary canal.

(2) Drainage System

Existing rivulet will be utilized as far as possible for drainage system. Drainage canals to be newly constructed will be the main canals for draining water within the farm land.

(3) Road Network

On the right bank of the Aguan River, access and in-farm roads will be constructed as well as the improvement of existing road.

Only existing road will be improved on the left bank.

(4) Land Preparation

Land preparation will be carried out for uncultivated areas and pastures, in which some parts in non-irrigated area will be excluded.

General features of facilities required in the project area as set out below.

Facilities	Phase I	Phase II	Total
I Irrigation Facilities			
1. Head Works	2 Middle Aguan Jaguaca	2 Upper Aguan Mame	4
2. Siphon	-	1 Mame	1
3. Pump Station	1 Middle Aguan Q=2.141 m^3/S ϕ700 x 2	1 Upper Aguan Q=0.446 m^3/S ϕ350 x 2	2
4. Main Canal	L=39,750 m Q=0.206 4.059m^3/S I=1/1000∿1/2500 Earth Canal Siphon 31 Check gate 9 Chute 1 Box culvert 3 Waste way 3 Diversion Works 43	L=33,900 m Q=0.212 2.212m^3/S I=1/1000∿1/2000 Earth Canal Siphon 10 Check gate 7 Chute 2 Box culvert 3 Waste way 4 Diversion Works 70	L=73,650 m Q=0.206∿4.059m^3/S I=1/1000∿1/2500 Earth Canal Siphon 41 Check gate 16 Chute 3 Box culvert 6 Waste way 7 Diversion Works 113
5. Secondary Canal	L = 42,500 m Q=0.089∿0.357m^3/S I=1/250 ∿ 1/600 Earth Canal Aqueduct 2 Farm pond 51 Tractor passege 1,030	L = 38,500 m Q=0.089∿0.357m^3/S I=1/250 ∿ 1/600 Earth Canal Aqueduct 2 Farm pond 13 Tractor passege 810	L = 81,000 m Q=0.089∿0.357m^3/S I=1/250 ∿ 1/600 Earth Canal Aqueduct 4 Farm pond 64 Tractor passege 1,900
II Drainage Facilities			
1. Drainage Canal	L = 36,650 m Q = 4.8∿15.2 m^3/S I=1/200 ∿ 1/550 Earth Canal Drop 89	L = 27,950 m Q = 3.8∿15.2 m^3/S I=1/200 ∿ 1/550 Earth Canal Drop 1	L = 64,600 m Q = 3.8∿15.2 m^3/S I=1/200 ∿ 1/550 Earth Canal Drop 90

Facilities	Phase I	Phase II	Total
III Road Facilities (Right Side)			
1. Access Road	L = 16,800 m B = 6 m Road to be constructed L = 16,000 m Existing road L = 800 m Bridge 16	L = 30,700 m B = 6 m Road to be constructed L = 21,150 m Existing road L = 9,550 m Bridge 22	L = 47,500 m B = 6 m Road to be constructed L = 37,150 m Existing road L = 10,350 m Bridge 38
2. In-farm Road	L = 49,950 m B = 4 m Road to be constructed L = 20,650 m Existing road L = 29,300 m Bridge 21	L = 70,700 m B = 4 m Road to be constructed L = 21,400 m Existing road L = 49,300 m Bridge 17	L = 120,650 B = 4 m Road to be constructed L = 42,050 m Existing road L = 78,600 m Bridge 44
(Left Side)			
3. Access Road	-	L = 34,500 m B = 5 m Existing road L = 34,500 m	L = 34,500 m B = 5 m Existing road L = 34,500 m

N.B. Area I: Between Saba and the Jaguaca River
Area II: Between Olanchito and the Jaguaca River

4.8 Social Infrastructure Plan

In order to resettle farmers in the Aguan Valley where relatively hard climatic conditions in relation to the rest of the country, the consolidation of such social services as water supply, education, public health will be indispensable. Desertion has been reported in Phase I and II Lower Aguan Project due to inadequate provision of social services.

In this Feasibility Study, to comply with the Scope of Works of the Study, only basic considerations will be made in respect to the social infrastructure plan; proposed facilities will be located on the map without including their designs and cost estimation (see Fig. 4-18.)

4.8.1 Public Health

In the urban area of Olanchito, the construction project of a public hospital has been suspended due to the lack of financial resources. The completion of this hospital is desirable, because of the absence of a hospital in this area and neighboring regions of the project area.

Although, the municipalities of Olanchito and Saba each have a CESAMO, insufficient services both in human and other reasons, have prevented many patients in the region from being seen by doctors. On the other hand, many farmers in the rural area can not go to CESAMO because of the non-availability of transportation. Considering these circumstances, it is recommended that a new CESAMO be installed in the middle zone between Olanchito and Saba.

As a result of a survey carried out with medical experts, it has been disclosed that most of sicknesses in the region are based on the absence of basic medical and hygienic knowledge. In this sense, it is advisable to construct more CESARs where personnel can regularly promote medicine and hygiene.

4.8.2 Educational System

Firstly, the improvement of educational services in material and quality is required. Presently no secondary school is to be found within the project area. Those who wish to go to secondary school, have to go to Olanchito or Saba lodging at a house in an urban area or commuting by bus. It being expensive to go to secondary school, only few farmers within the project area can afford the expenses incurred. With the development of agrarian reform, the number of resettled families will increase and a secondary school is required within the project area. It is proposed to increase the number of secondary schools in the future according to the further increase of families.

In the field of primary schools, the first task to be considered is the equilibrium of education opportunity between urban and rural areas. For this purpose, it is essential to provide teachers and classrooms needed to offer complete schooling of six years. Thereafter, substantial equipment will be prepared gradually. In view of the improvement in the quality of education, the share of scientific materials should be increased and physical and artistic education should be introduced. To comply with these objectives, well-trained, highly educated teachers are required. As one proposal for the remedy of undernourishment among pupils in the area, the introduction of school meals should be taken into consideration. The location of each primary school will be proposed in consideration of the number of pupils attending school.

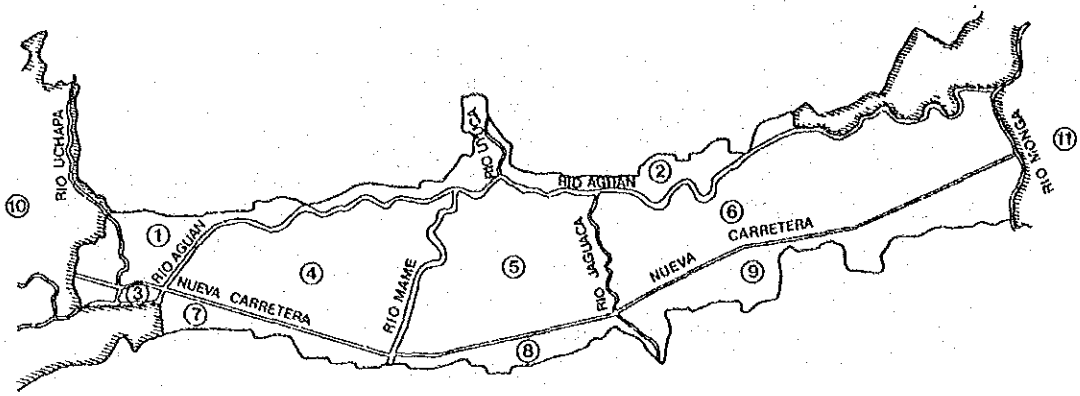
4.8.3 Power and Water Supply

One 138 KV transmission line passes at the foot of mountain on the left side of the Aguan River en route to link three sub-stations, viz: La Ceiba, Isleta and Coyoles. Furthermore, a distribution line (34.5 - 19.9 KV) from sub-station at Coyoles passes the urban area of Olanchito and reaches the community of El Juncal passing by San Francisco connecting secondary lines with this distribution line. It is possible to supply power to those areas located in Olanchito, El Juncal, and San Francisco. On the other hand a new distribution line should be installed on the right bank of the Aguan River between El Juncal - San Francisco and Saba.

As a result of a groundwater investigation, it has become clear that the available quantity of underground water per well is 200 - 1,000 m^3/day in alluvial and 100 - 500 m^3/day in diluvial formations. Apart from this, in the course of the boring operation, one good well was perforated near Maloa. With the provision of a motor pump, it is advisable to utilize this well for the supply of potable water to the surrounding communities.

4.8.4 Other infrastructures

As the agrarian reform program develops in the project area, new communities will appeare and, in promoting activities among cooperative members, such facilities a local markets, community centers and churches etc. will be recommended to be provided with each community.



		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	
A	RESIDENTIAL AREA	48	21	0	51	35	54	10	4	56			279
B	UPLAND CROPS	1	29	0	182	77	640	10	0	371			1310
C	PASTURE	965	182	190	1265	1840	714	225	305	330			6015
D	PLANTATION	15	0	0	127	10	0	5	0	0			157
E	RIVER	231	165	90	210	175	452	60	15	35			1433
F	AREA WITH SLOPES MORE THAN 8°	503	237	35	172	160	246	215	100	363			2031
G	ROAD	14	0	6	10	8	21	4	11	14			88
H	UNCULTIVATED AREA	654	361	69	1583	1625	3363	181	95	1406			9342
I	SUB-TOTAL	2430	995	390	3600	3930	5495	710	530	2575			20655
	EXCLUDED AREA										2590	2280	4870
	TOTAL												25525

1. The area was calculated based on the topographic map with the scale 1/5000 prepared by JICA
2. Area in numbers 10 and 11 was excluded frow the Project Area
3. Arable area: (B + C + D + H) = 16824 ha

Fig. 4–1 Development Area

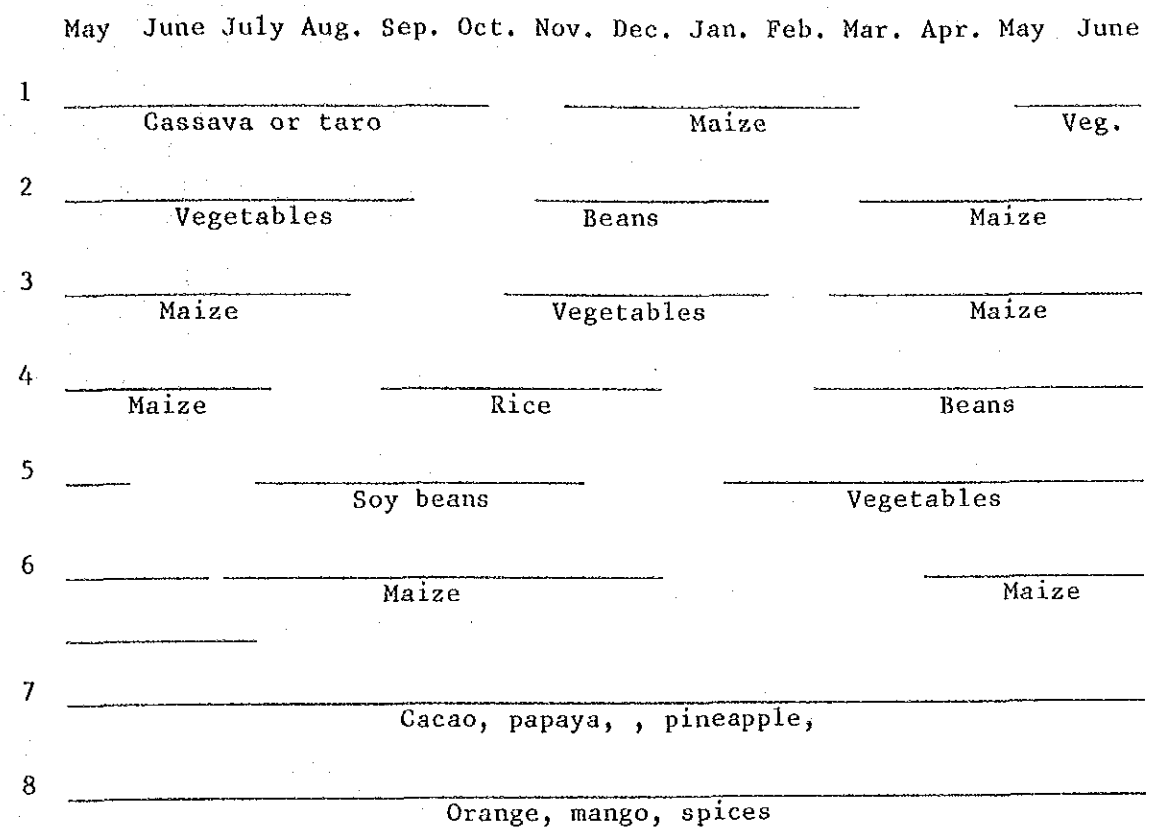


Fig. 4–2 Rotation of Crops Within a Single 12 Month

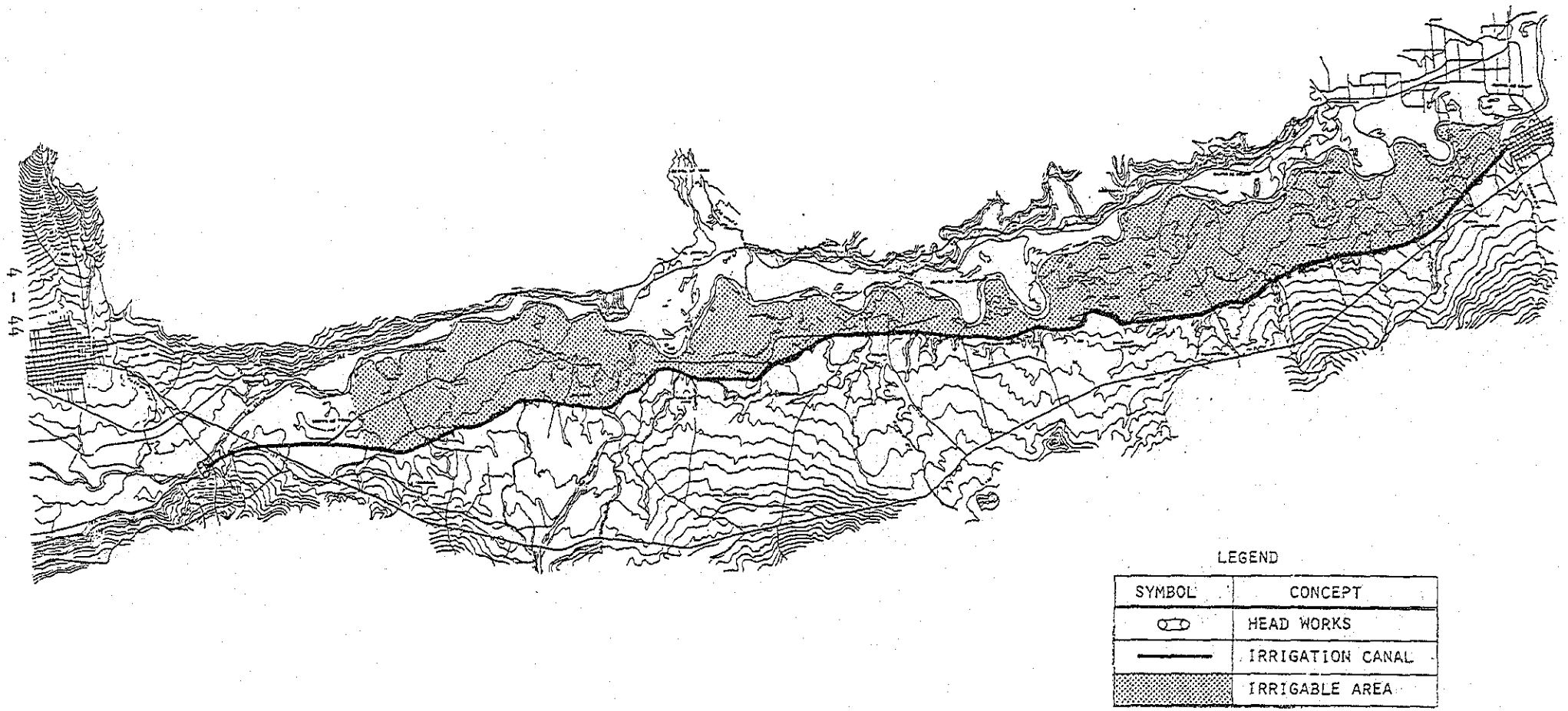
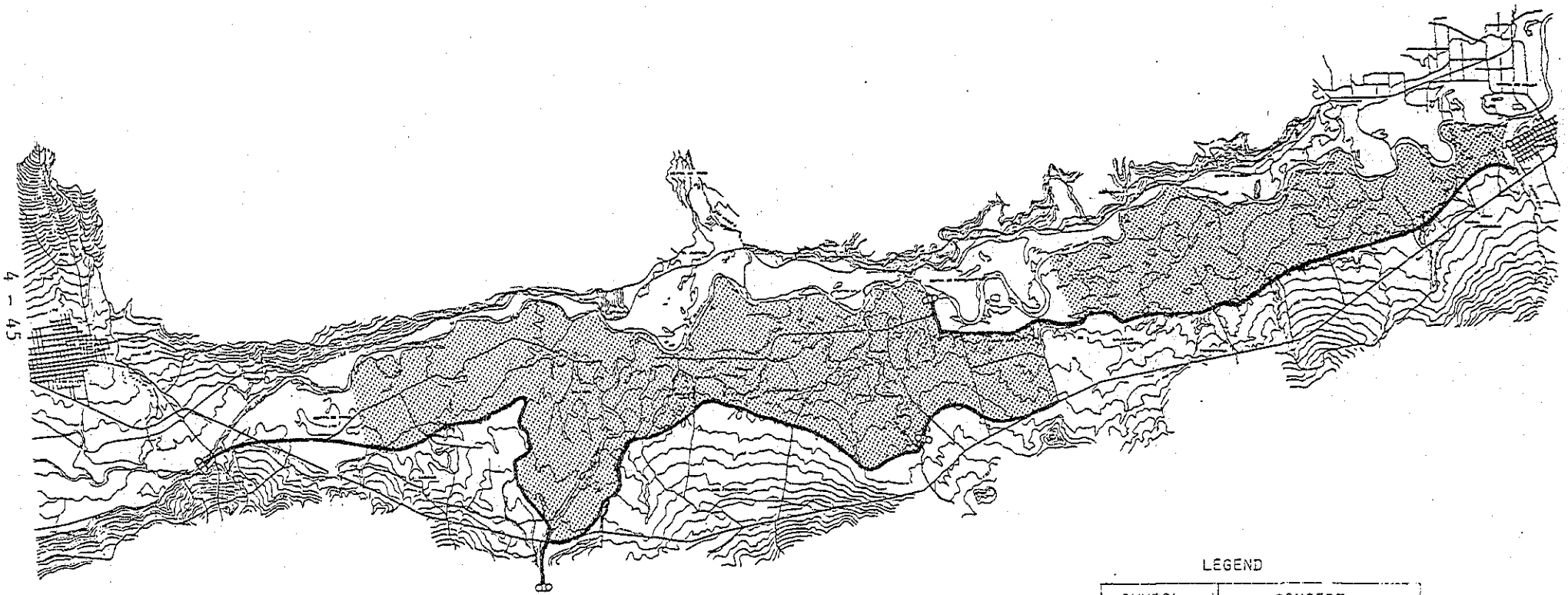


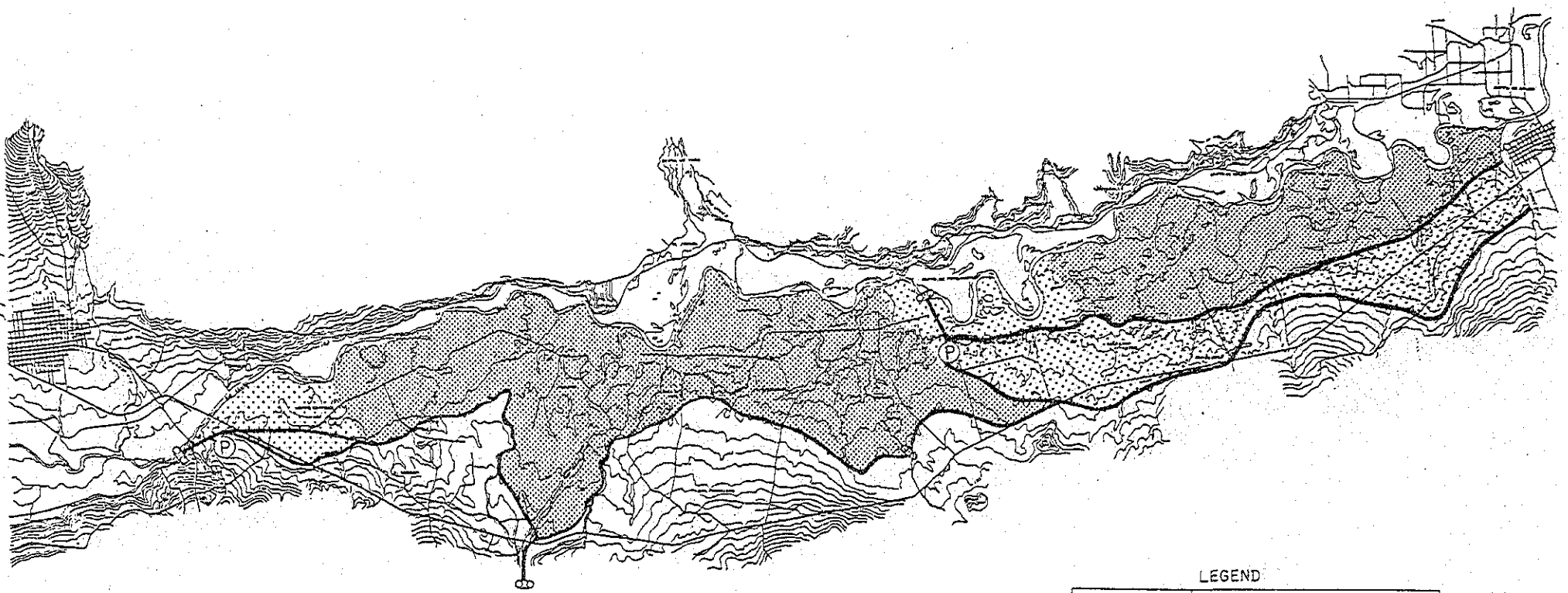
Fig. 4–3 IRRIGATION SYSTEM (PLAN 1)



LEGEND

SYMBOL	CONCEPT
	HEAD WORKS
	IRRIGATION CANAL
	IRRIGABLE AREA

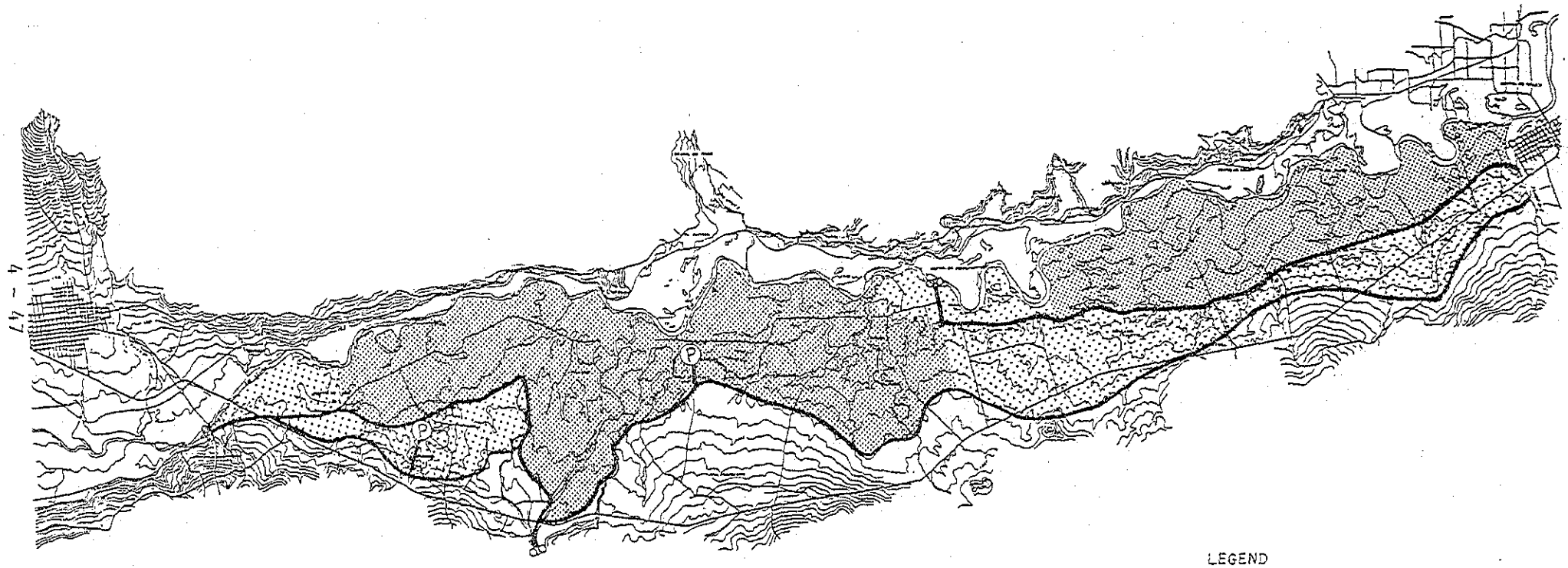
Fig. 4–4 IRRIGATION SYSTEM (PLAN 2)



LEGEND

SYMBOL	CONCEPT
⊂⊃	HEAD WORKS
Ⓟ	PUMP STATION
———	IRRIGATION CANAL
	IRRIGABLE AREA
	IRRIGABLE AREA (PUMP)

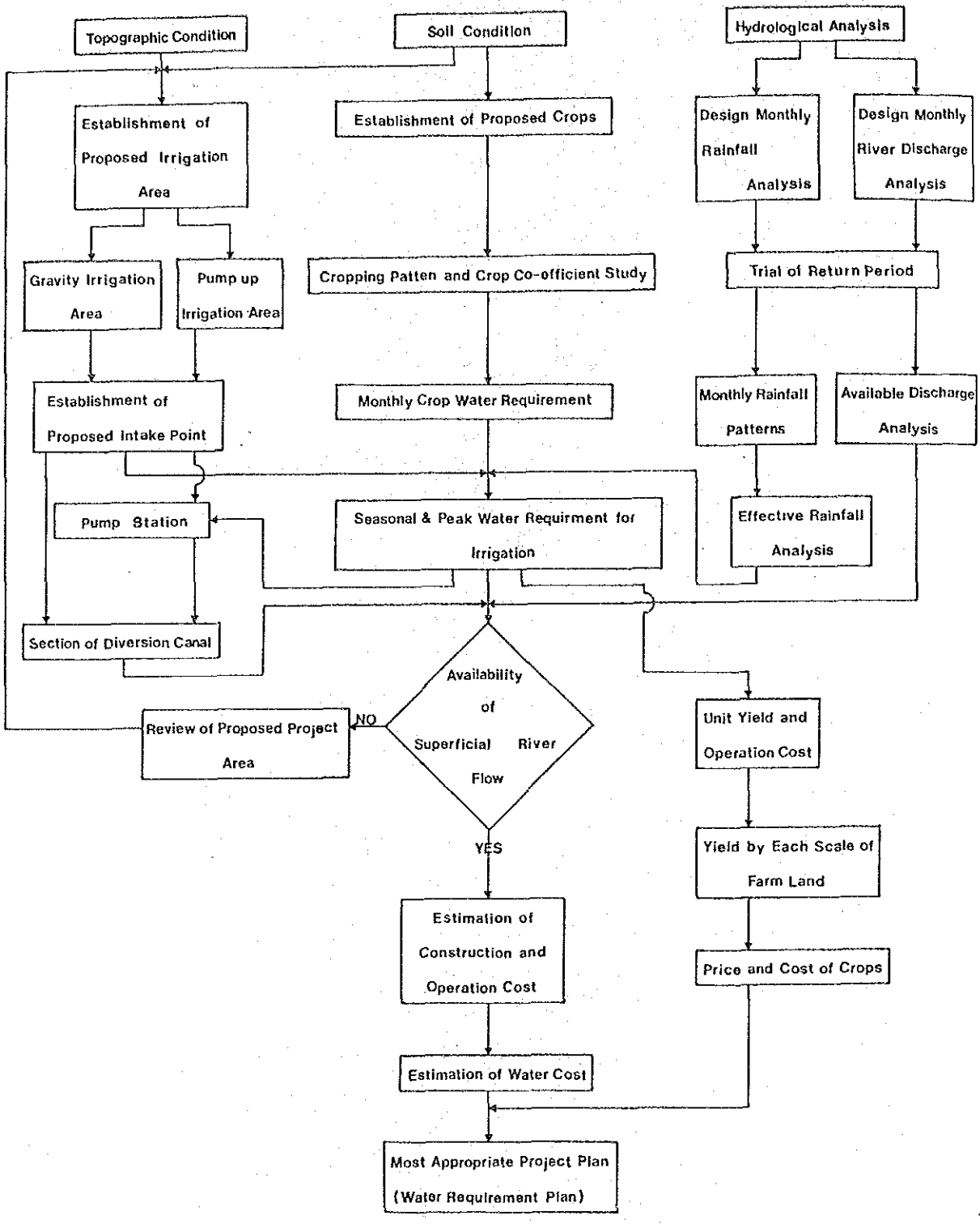
Fig. 4–5 IRRIGATION SYSTEM (PLAN 3)



LEGEND

SYMBOL	CONCEPT
⊂⊃	HEAD WORKS
Ⓟ	PUMP STATION
———	IRRIGATION CANAL
▒▒▒	IRRIGABLE AREA
▒▒▒	IRRIGABLE AREA (PUMP)

Fig. 4–6 IRRIGATION SYSTEM (PLAN 4)



FLOW CHART OF STUDY

Fig. 4–7 Flow Chart of Irrigation Study

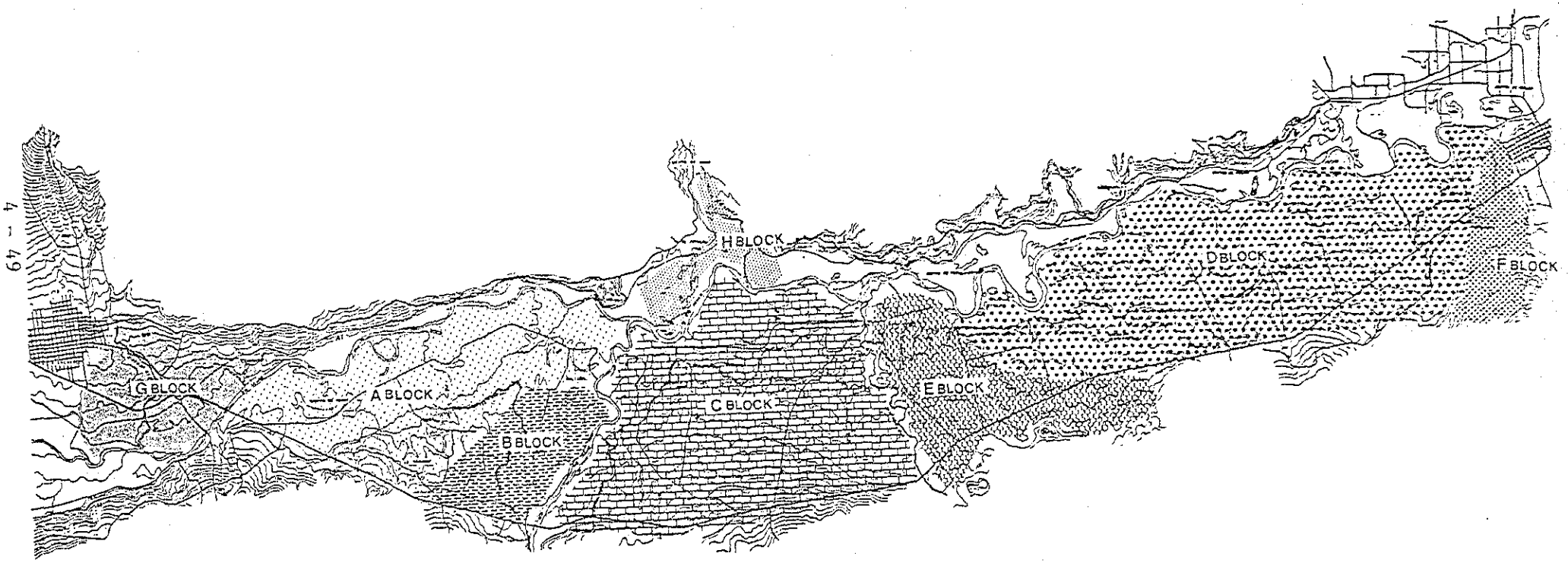


Fig. 4–8 Block Model of Drainage Area