CHAPTER 1: INTRODUCTION

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1.1 PREFACE

The Draft Final Report has been elaborated in due compliance with the Scope of the Work (S/W) for the Feasibility Study on the Limon del Yuna Area Agricultural Development Project (herein after referred to as "the Study") which was agreed upon between Instituto Nacional de Recursos Hidráulicos (INDRHI) of the Dominican Republic and Japan International Cooperation Agency (JICA) on August 25, 1993.

The Study has been carried out in two phases: Phase I and Phase II; during the Phase I, which covered four months from August to November, 1994, fact finding of the Study area and formulating the basic development concepts were realized, meanwhile in the course of the Phase II - from January to June, 1995, supplementary study to complement the Phase I of the Study and formulation and evaluation of alternative plans for agricultural development of the Study area were conducted.

This report, which resumes the fruits of the said Study, consists of the following three volumes:

Volume I:	Main Report
Volume II:	Annexes (Annex A ~ Annex H)
Volume III:	Annexes (Annex I ~ Annex N)

1.2 BACKGROUND OF THE STUDY

The Dominican Republic occupies the eastern part of the Hispaniola Island, the second largest island of the Great Antilles, sharing the border with the Republic of Haiti. The country has an extension of 48,422 km^2 and its population reached 709 thousand in 1993.

The mainstay of the Dominican Republic is agriculture and the sector's exports represented 34% of the total exports in 1993 and employed 22% of the economically active population of the country. Recently the country has been suffered from sluggish economic behavior due to decline of the foreign exchange earning attributable to dull performance of the international price experienced by major exports (sugar, coffee, cocoa and tobacco).

Under the circumstances, the Government of the Dominican Republic aims to promote agricultural sector taking measures for development of alternate industry for sugar-related business, exoneration of tariff and duties on imported agricultural inputs and machinery, expansion of irrigable areas by means of construction and rehabilitation of irrigation system. The construction and rehabilitation of irrigation system was placed as one of the priority policies within the Investment and Action Program of the Public

Sector 1992-1996. It is worth while to point out that, although being considered as the staple of the diet of the country, rice has been inconsistently produced in its production for the last decade, and hence an increase of its production becomes a stressing subject in view of attaining self-sufficiency of the grain and saving of exchange earnings.

The AGLIPO area is an abbreviation for the three sectors: Aguacate-Guayabo, Limon del Yuna and El Pozo which are extended over a territory of 25,000 ha. The Lower Yuna Basin which comprises the basin of Boba-Baqui river system in addition to the AGLIPO area is considered to be one of the major rice production areas of the country, and promoting further rice production in the area, the Government of the Dominican Republic requested the Government of Japan to carry out a technical cooperation for the feasibility study of AGLIPO area agricultural development project in May 1979.

In response to the above-mentioned request and within the context of the prioritization among three sectors, the Government of Japan agreed to implement the feasibility study on agricultural development of El Pozo area as the phase I of the AGLIPO project from 1980 to 1982; this feasibility study was followed by implementation of construction works during 1984-1990 with a loan of the Government of Japan. As the next phase (phase II) of the AGLIPO project, the Aguacate-Guayabo area was taken up and another feasibility study on this area was conducted from 1985 to 1986; it is expected that the development of this area will be put into implementation with a loan of the Government of Japan in 1995.

The Limon del Yuna area is found over a plain land with an extension of 120 km^2 which is located on the right margin of the Yuna River, the second largest river of the country. This area is characterized by stagnated agricultural production due to physical deterioration of existing irrigation works, under-development of canal network, deficiency of drainage network, absence of flood mitigation measures, and degradation of roads function, although the level of infrastructures development is considered to be the highest among the three sectors constituting the AGLIPO area. With an eye to overcoming this situation, the Government of the Dominican Republic requested the Government of Japan a technical cooperation for formulating an agricultural development project in the Limon del Yuna area as the phase III of the AGLIPO project in May 1993. In response to this request, the Government of Japan dispatched a preliminary survey mission to conclude and discuss the S/W for the Study in August 1993.

The schedule for feasibility study and implementation of detailed design/construction works for the respective three sectors of the AGLIPO project is as given below:

Sectors	Feasibility Study	Detailed Design and Construction Works
El Pozo	1980 - 1982	1984 - 1990
Aguacate-Guayabo	1985 - 1986	To be started in 1995
Limon del Yuna	1994 - 1995	

The AGLIPO area had been suffered from frequent attacks of flooding of the Yuna river in the past due to insufficient section capacity of the river, but the completion of the Rincon dam (in 1978) and the Hatillo dam (in 1982) has contributed greatly to alleviation of flooding damages. The completion of the El Pozo project has also benefited flood mitigation. The completion of these projects has changed ecological and socio-economic conditions of the AGLIPO area.

1.3 OBJECTIVE OF THE STUDY

The objective of the Study is to formulate the Limon del Yuna area agricultural development project and to evaluate it from technical, economic and social points of view.

1.4 THE STUDY AREA

The Study area is extended over the downstream plain on the right margin of the Yuna river with an approximate area of 120 km^2 and is limited by the Yuna river to the north, by the Los Haitises Range to the south, by the Barracote river to the east, and by the Cevicos river to the west.

1.5 REPORTS

The present Study was conducted from March 1994 to August 1995 in accordance with the Scope of Work agreed upon between the Governments of the Dominican Republic and Japan. During the course of the Study, the following reports have been submitted to the Government of the Dominican Republic by the Study Team.

Reports	Timing of Submission	No. of Copies English	No. of Copies Spanish
Inception Report	At the commencement of the Study (August 1994)	5	10
Progress Report (1)	At the end of the Phase I Field Works (September 1994)	5	10
Interim Report	At the commencement of the Phase II Field Works (January 1995)	5	10
Progress Report (2)	At the end of the Phase II Field Works (March 1995)	5	10
Draft Final Report	At the end of Phase II Home Office Works (August 1995)	5	20
Final Report	At the end of the Study (November 1995)	30	50

CHAPTER 2: NATIONAL SOCIO-ECONOMIC BACKGROUND

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2.1 MACROECONOMIC OVERVIEW

The Dominican Republic occupies two-thirds of the Hispañola Island with a total area of 48,442 km^2. According to the official data of the 7th National Census for Population and Living, the country had a population of 7,089 thousand in 1993 and it is estimated that around 55% of them lived in urban area. The inter-census growth rate between 1981 and 1993 was 1.6% per annum.

According to the preliminary figures prepared by the Central Bank, the Gross Domestic Product (GDP) of the Dominican Republic in 1993 was RD$ 4,228.7 million at the constant price of 1970, which had been grown at an annual average rate of 1.6% for the period 1989-93. The sectors which had contributed greatly to GDP formation were: manufacture (18.3%), agriculture and livestock (13.2%), commerce (12.7%), government expenditure (8.8%) and construction (8.0%).

The current account within the balance of payment corresponding to the year of 1993 showed a deficit of US$ 299.6 million to have been caused by negative performance of the trade balance (US$ -1,606.9 million). In this country the trade balance has been consistently negative and the amount of the deficit has increased recently due to correlated effect of the decline of exports in value terms and the expansion of imports. The shrinkage of exports stemmed from the continuous depression of such traditional exports as sugar, coffee and cacao in the international markets. The net international reserves as of the end of 1994 was estimated to be a deficit of US$ 464 million. The Dominican Republic was the only country among Latin-American countries which had reduced external debt during 1994 with a balance of US$ 3,992 million at the end of December 1994, as contrasted with US$ 4,552 million at the same period of the previous year. end of December 1991.

The exchange rate of the Dominican peso against US dollar had been stable during 1994, with a variation of only 3% (from US$ 1 = RD$ 12.50 to US$ 1 = RD$ 12.87) and the inflation rate to cover the same period was around 13%.

2.2 PERFORMANCE OF THE AGRICULTURAL SECTOR

The agricultural sector including forestry and fishery is the most important sector except the manufacture within the context of the GDP formation. Despite the fact, for the last four years 1989-1993, the agricultural sector had attained an accumulated growth as low as only 0.3% per year, the figure far inferior to that of the total GDP (1.6%). As a consequence of this unfavorable performance, the share of the agriculture sector within the total GDP had fallen from 13.8% in 1989 to 13.2% in 1993.

This deteriorated performance experienced by the agricultural sector may be explained by various reasons, of which the following may be stressed: 1). Discouragement in conducting farming among farmers due to deterioration of international price for traditional exports and reduction of the preferential quota for importation of sugar in the United States, 2) Inappropriate use of land and water resources, 3) An absence of

adequate cropping technology, 4) Inconsistency of governmental policies (provision of agricultural credits, agrarian reform and marketing and prices, among others), and 5) Low level of investment assigned to the sector.

Agricultural exports contribute greatly to generating foreign exchange of the country; in 1993, the total value of foreign exchange was US$ 511.5 million, of which US$ 185.9 (36.3%) million was covered by four traditional agricultural exports (sugar, coffee, cacao and tobacco).

Production of paddy for the last ten years (1984-1993) showed an irregular accomplishment characterized by the ups and downs in its harvest level; a comparison of the production amount had disclosed that there was a drop by 10% in 1993 in comparison with in 1984 as a consequence of a transition from 357.6 thousand tons in 1984 to 319.6 thousand tons in 1993, although a peak production was registered in 1992 reaching 405 thousand tons.

Maize and sorghum are considered to be important crops for feeding animals and both of them are decreasing their production recently. Sugarcane continued to have reduced its production for the decade; tobacco, on the other hand, attained the maximum output in 1990, but it was precipitated in the next year, and this tendency continued in the proceeding years of 1992 and 1993. Production of the remaining traditional exports (coffee and cacao) had gone up and down year by year during the period 1984-93.

The livestock production is represented by chicken, beef, milk and eggs, which accounted for 50.9%, 17.6%, 17.2% and 13.2% of the total value in livestock production in 1993, respectively. In the Dominican Republic, poultry farming has been expanded for the last ten years, while cattle farming has been stagnated.

2.3 POLICIES ON AGRICULTURAL DEVELOPMENT

In 1990, the Government of the Dominican Republic, forced by the depression of the national economy which was the outcome of the deficiency in trade balance, an accumulation of external debt and galloping inflation, adopted a series of measures aiming to take up immediately an adjustment program for the healthy performance of the national economy, and this governmental action was reflected on the agricultural development policies.

Since then, structural reform programs comprised the reduction of the public investments, elimination of subsidiaries generalized to consumption goods, abolition of controls over prices of various agricultural products, liberalization of interests among banking institutions, exoneration of taxes on traditional exports, and less participation of the public sector in the course of the marketing process have been put in force.

The priority in agricultural production is given to the crops which tend to satisfy domestic demand, to serve food security and to contribute foreign exchange earning. And, so far as cereal production is concerned, major endeavor shall be made towards stable production of rice and increase of sorghum production so that the pressure on demand of wheat and maize may be released.

During the decade of 80', the marketing policies in the Dominican Republic are featured by an aggressive intervention of the public sector, but since 1990, in line with structural reform programs, the government has undertaken liberalization measures for marketing and pricing of agro-products. As a consequence of these policies, governmental intervention on pricing agricultural crops is left for only four crops composed of red haricot bean, garlic, onion and potato, although INESPRE had established supporting prices for the majority of crops up to 1987.

2.4 POLICIES ON DEVELOPMENT OF IRRIGATION SYSTEM

The public agency responsible for irrigation system in the Dominican Republic is National Institute for Hydraulic Resources (INDRHI). INDRHI, founded in 1965, is authorized by the Law No. 6 of 1965 as the maximum national entity which regulates and controls the use of superficial and underground water of the country. Functions of INDRHI in relation with irrigation system are, among others,:

- To organize and manage development and conservation of national irrigation system;
- To propose, study and construct irrigation and drainage works;
- To facilitate organization of water users;
- To establish standard and criteria for construction of irrigation and drainage works;
- To supervise, operate and conserve irrigation system; and
- To collect water charge from users.

Before creation of INDRHI, due to political, economic and social difficulties, development of irrigation works had been limited to smaller scale projects. From the beginning of 1970 an important expansion of irrigated area had been recorded with construction of such dams as Tavera, Valdesia, Rincon, Sabana Yegua and Hatillo. As of 1994 a total of 146 projects including 9 dams are in operation with total irrigated area of 254,197 ha (Plan Nacional de Ordenamiento de los Recursos Hidraulicos, OEA-INDRHI, preliminary document, 1994).

The Law which governs water use is the Law 5852 of 1962. The most important and essential aspects of this law are: the domain of public water, the necessity to apply for permission for use, prohibition to contaminate sources of water resources, water charge establishment system, and fixture of water resources development policies.

Al present in view of renovating legalization on water use, an elaboration of the Water Code has been made and this code is being discussed at the National Congress for approval. The highlighting aspects of the Water Code are: To establish that any individual and juridical person is required to get permission and authorization or license for use of water; To pay special attention in development of underground water; To declare domain of public purpose for construction works to be implemented by public sector; and To propose incorporation of water users' association within irrigation projects.

Accordion to the above-mentioned information it is registered that the physical area for irrigated lands accounts for 254 thousand ha, which is equal to approximately 10% of the total arable lands of the country and almost half of potentially irrigable lands. And, within

these irrigated areas, it is reported that the efficiency of water conveyance does not reach 40%, calculated in terms of conduction, operation and application to farmlands (PLAN NATIONAL DE ORDENAMIENTO DE LOS RECURSOS HIDRAULICOS, OEA-INDRHI). This situation may be arisen from: 1) deficiency of water in time of necessity; 2) inadequate system for operation and maintenance of existing infrastructures; 3) lack of tertiary facilities; 4) absence of drainage works at farms; and 5) existence of fallow lands.

Under the circumstances cited above, the attention of the governmental policies shall be paid to making investment in new irrigation works, maintenance and effective use of existing infrastructure, and more rational use of water resources. Particularly, regarding the operation and maintenance of irrigation system major effort had been oriented to elevating water charge collection rate.

Another important trend relevant to irrigation system of the country is to turn over the responsibilities and undertakings of irrigation works from INDRHI to water users' association. The background for promoting this turn-over policy is that, in spite of the government effort to invest in irrigation projects, the benefits generated by these projects were not as high as those expected at planning stage, and that this deficient generation of benefits is mainly caused by inadequate operation and maintenance of completed irrigation works. This turn-over will not be put into force drastically but step by step; up to date, turn-over of irrigation system is limited to canals smaller than secondary one and to the tertiary drainage canals, therefore responsibility of main irrigation canals and drainage canals falls still on hand of INDRHI.

The sum of irrigated area at projects with "Junta de Regantes" reaches 24% of the total irrigated area ofd the country, but it is informed that the "Juntas de Regantes" which have attained an anticipated level of administration and operation are limited; this situation may be rooted to the fact that irrigation system at projects with "Junta de Regantes" is under-developed. It is thus advisable that promotion for turn-over of irrigation system from INDRHI to water users should be accompanied by improvement of irrigation system.

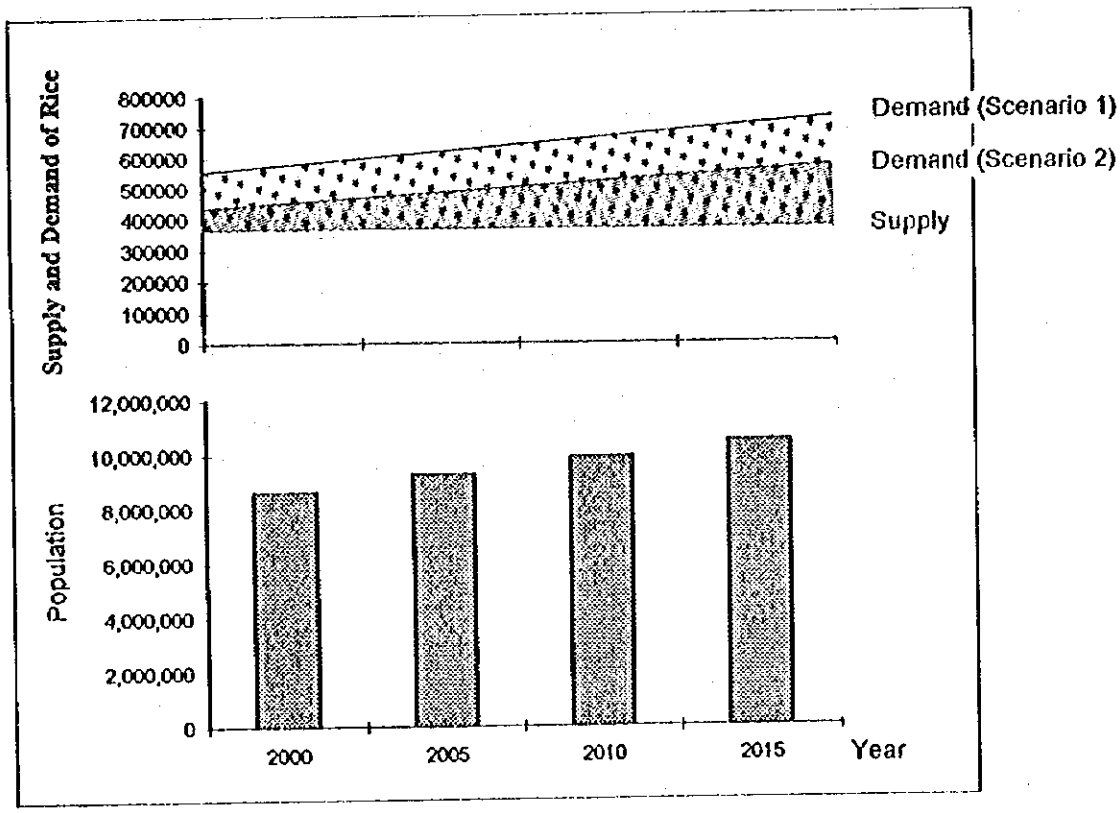
2.5 NATIONAL PRODUCTION, SUPPLY AND DEMAND OF RICE

According with the information of the Rice Research Center (CEDIA), planted and harvested area, output and unit yield of rice for the year of 1993 were: 86,793 ha, 88,336 ha, 317,073 ton and 3.59 ton/ha, respectively. The development of rice production is one of the important agricultural policies and, in proof of the same, a considerable portion of INDRHI's budget for public works are allocated to construction, improvement and rehabilitation of irrigation system; in IAD's agrarian reform lands nearly half of cultivated area is covered by rice. Furthermore, almost 80% of agricultural credit of the Agricultural Bank (BAGRICOLA) are disbursed for rice cultivation.

Rice is a vital foodstuff consumed by the Dominican people representing approximately 6.7% of the total household expenses and 15% of the household expense for foodstuffs. It is estimated that the Dominican people consumed 54.4 kg of rice yearly, equivalent to 149 g/day, as an average quantity for the decade (1984-1993), which is far lower than the recommended quantity (190 g/day) to satisfy the calorie-protein requirements (information of ONAPLAN).

According to the Latin American Center for Population, the Dominican Republic will have an approximate population of 10,480,000 for the year of 2015. Supposing that the production and consumption level will be maintained status quo (Scenario 1) there would be a deficit of 304,000 tons of rice in 2015 to meet the proposed demand anticipated by expansion of population, while if the consumption level for rice would be raised to the above-mentioned recommended level, the deficit of rice would be expanded to 386,000 tons.

Projection for Growth of Population and Supply and Demand of Rice in the Dominican Republic



2.6 THE AGLIPO PROJECT AREA

The AGLIPO area consists of three sectors: Aguacate-Guayabo, Limón del Yuna and El Pozo, which are extended over the lower basin of the Yuna River, the 2nd largest river of the country. Endowed with favorable natural conditions such as climate, soils and topography, this area is considered to be an optimum area for rice production, thus paddy has been cultivated for long years. On the other hand, in view of promoting rice production there, the Government of the Dominican Republic has put into force an agrarian reform project since 1962 at El Pozo, since 1967 at Limón del Yuna and since 1969 at Aguacate. This AGLIPO area is alienated from major cities of the country without

being endowed with tourist resources at attend great number of tourist. The area forms part of the country's leading agricultural zone located at lower basin of the Yuna river, so living standard of local inhabitants here will not be ameliorated if farming of higher productivity will not be realized.

The Dominican Government had decided to develop the area with emphasis laid on construction of irrigation facilities so that an increased and sustainable rice production would be attained. As a first phase of the project, El Pozo sector was taken up, since the sector was socio-economically the least developed area among the three sectors of the AGLIPO area; construction of irrigation facilities was completed in 1990. Subsequently, the Aguacate-Guayabo sector will be benefited by development of irrigation system and detailed design for the system will be proceeded in 1995. Limón del Yuna sector is the only sector among AGLIPO area which had an irrigation system at the initial stage of the agrarian reform project, but structural deterioration of the system has become prominent recently, so rehabilitation and intensification of the system is required for the stable production of paddy

The actual situation and future forecast of rice production for the three sectors of the AGLIPO area is as summarized below.

Unit: ton

	Actual	Year 2000	Year 2015
El Pozo	40,600	55,200	75,000
Aguacate-Guayabo	10,200	19,600	71,000
Limon del Yuna	32,500	51,900	69,000
Total	83,300	126,700	215,000
Increased Output	0	43,400	131,700

CHAPTER 3: FACT FINDING ON THE STUDY AREA

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3.1 GENERAL ASPECTS

The Study area is located in the latitude 19°10'N and in the longitude 69°54'W with an approximate territorial extension of 120 km^2. The area is surrounded by the rivers of Yuna (to the north) and Cevicos (to the west), the Barracote Canal (to the east) and the Haitises Range (to the south). This area lies on wide alluvial delta formed by the Yuna river and its major portion is featured by the flat physiognomy with an altitude ranging from 3 to 17 meters above sea level. According with climatic classification, the area belongs to the tropical humidity zone and semi-tropical humidity zone.

The great majority of the Study area belongs to Villa Riva municipality, the Province of Duarte, meanwhile one small village situated at the confluence of the Yuna River with the Barracote Canal belongs to Sánchez municipality, the Province of Samaná. These two provinces together with the provinces of Salcedo, Sánchez Ramírez and María Trinidad Sánchez constitute Cibao Oriental Sub-region which occupies 11% of the national territory.

The Study area is connected with the rest of the country through mainly four ways: to cross either concrete-reinforced bridge constructed over the Yuna River leading to Arenoso or Samaná or floating bridge (concrete-reinforced bridge is under construction nearby) adjoining the central area of Villa Riva, and to take a provincial road crossing through the Haitises Range, and to take the road along the right margin of the Yuna river leading to Cotui. The ordinary route bound for Santo Domingo is Villa Riva - Los Abanicos - Pimental - Cotui - the Duarte Highway and taking this route (about 170 km) one can reach Santo Domingo within three hours.

The Limon del Yuna area has been developed with the implementation of IAD's agrarian reform project which started in 1967; At the time of initial stage a total of 1,660 ha of land was distributed to 384 families; settlement was continued to 1974 when the number of beneficiaries and the extension of distributed lands reached 1,391 families and 6,959 ha. This agrarian reform project area accounts for 64% of the total extension of the Study area and families benefited by the project represent almost 80% of the total families. The Limon del Yuna agrarian reform project is an important project within context of IAD's land settlement program, because it is one of the only six out of 417 land settlement areas which are supervised not by regional office, but directly by the central office.

The Study area is an agricultural zone represented by rice production; close to 95% of households of the area engage in crop and livestock production. Income of farmers has decreased recently to such level as RD$ 4,500/year on average as a consequence of inconsistent supply of irrigation water, flooding damages, shortage of agricultural credit, division of farmlands among family members and so on. Under such situation not a few farmers have to work at other farms or at public organizations to make up for deficiency of their income. Living standard of these farmers has not been ameliorated because half of households of the area are not supplied neither electricity nor potable water.

With regard to the population of the Study area, there is no updated reliable information, so reference was made to the 1981's census data; in the Dominican Republic another census on population and housing was carried out in 1993 after 1981, but its detailed information covering population at the smallest community has not been published yet. In 1981, according to the said census, the Study area which comprises 23 villages belonging to two municipalities cited before had a population of 14,629, of which 7,968 (54.6%) were male. The number of household was 2,794, so an average family member per household was 5.24. This population is equivalent to 47% of the total inhabitants of the municipality of the Villa Riva. The 1993's census result was disclosed at the municipal level, and there was little change in terms of the number of inhabitants between the two censuses (31,392 inhabitants in 1993 in contrast with 31,454 inhabitants in 1981), it is thus estimated that the actual number of inhabitants in the Study area remains more or less the same as that in 1981. It is worth while to add that about 500 people were migrated from the Haitises National Park zone to settle in the Study area, because the Dominican Government evacuated these people enacting an ordinance to prohibit living within the national park. These people are former residents of the Study area, so this migration would not affect substantially the registered number of inhabitants in the Study area.

3.2 METEOROLOGY AND HYDROLOGY

3.2.1 Objective of the Study

The main objective of the meteo-hydrological study is to clarify the meteo-hydrological condition in the Study area. The Study area is limited by the Yuna river to the north, by Los Haitises Range to the south, by the Barracote river to the east and by the Cevicos river to the west. As the drainage condition of the Study area has been influenced by the water level of the Yuna and Barracote rivers, meteo-hydrological analysis was made to cover the whole basin of the Yuna river. Furthermore, the amount of water discharged at the Payabo river is one of the most important elements for the Study, therefore, the hydrological analysis on the Payabo river should also be required.

3.2.2 Field Survey

(1) Data collection

The following meteo-hydrological data were collected:

- Monthly rainfall (54 stations located within and adjacent to the basin of the Yuna River)
- Daily rainfall (2 stations - Barraquito, Abadesa)
- Monthly mean, maximum and minimum discharge (15 stations)
- Daily mean discharge (3 stations - Villa Riva, El Limon, Abadesa)
- Daily mean water level (3 stations - Villa Riva, El Limon, Abadesa)
- Suspended sediment data (3 stations - Villa Riva, El Limon, Abadesa)
- Spring discharge data (5 springs within the Study area)

(2) Discharge measurement

The discharge of the Payabo river, the Cascarilla drainage canal and main springs in the Study area were measured during the Phase I and II of field works.

3.2.3 Meteorological Study

(1) Climatic condition in the Yuna river basin

The climatic condition of the Yuna river basin can be classified into 2 categories based on its rainfall and mean temperature widely varying 1,500 ~ to 3,000 mm and 20 ~ 30 °C as follows:

- Tropical humidity zone (Eastern part from around western longitude 70°)

  This zone is characterized by annual rainfall of approximately 2,000 mm and monthly average temperature which never go below 25°C throughout the year.

- Semi tropical humidity zone (Western part from around 70° longitude) W

  This zone is characterized by annual rainfall of approximately 1,500 mm and monthly average temperature which ranges between 20 and 25°C; close to 3,000 mm of rainfall is observed in mountain area situated to the south-western part of the river basin.

The climate of the Yuna river basin is summarized as follows:

- Annual rainfall 1,500 ~ 3,000 mm
- Mean temperature 20 ~ 28 °C
- Maximum temperature 25 ~ 34 °C
- Minimum temperature 13~19 °C
- Relative humidity 80 ~ 90 %
- Evaporation 1,500 ~ 2,000 mm/year

In the Yuna river basin area, the highest amount of rainfall is recorded in May, when 13-15% of the annual rainfall is distributed; in August and November, rainfall is recorded at the proportion of 10-11% to the annual rainfall. On the other hand, only 5-6% of the annual rainfall is distributed to respective month of January, February and March, so these three months are regarded as dry season. The same climatological performance is observed over the total basin area as well as in other regions of the country except for western coastal region of the Atlantic Ocean.

There is few monthly variation in terms of climatological data other than rainfall with exception of evaporation.

(2) Climatic condition in the Study area

Processing data recorded at the Barraquito station, the climate of the Study area is summarized as follows:

- Annual rainfall 2,070 mm
- Mean temperature 26 °C
- Maximum temperature 33 °C
- Minimum temperature 18 °C
- Relative humidity 83 %
- Evaporation 1,460 mm/year
- Wind velocity 1.1 m/sec

The most rainy month falls on May which represents 15% of the annual rainfall and next to May, August and November are rainy months with share of 10% and 9% of the annual rainfall, respectively: meanwhile, the least rainy month comes to be January, February and March with a proportion fewer than 6% each of the annual rainfall. With respect to performance of temperature there is such a small difference as less than 15% between the annual average and the monthly average. In the same manner, the relative humidity present few variation all the year around. The maximum value of the daily relative humidity during 1983 and 1993 was 97% and the minimum value of the same was 71%. The highest evaporation is observed in May, followed by June, in contrast, the lowest of it is recorded in December.

3.2.4 Hydrological Study

(1) Rainfall analysis

The correlation coefficient of the monthly rainfall among the 54 rainfall gauge stations was calculated. Considering the location, correlation coefficient and data availability, 8 rainfall gauge stations were selected for the Thiesen Polygon method. Using the monthly rainfall and the Thiesen Polygon method, the average rainfall at the catchment area of Villa Riva, El Limon, Abadesa, the Yuna river confluence with the Payabo river and Payabo river basin was estimated. Approximately 1,700 mm of average annual rainfall was estimated in the catchment area of the Yuna river and around 2,000 mm was estimated for the Payabo river basin.

Using the daily rainfall data at Barraquito and Abadesa, the probability analysis was carried out for the following items and the results are summarized as shown below:

Return period	1/2	1/5	1/2	1/5
Annual rainfall (mm)	2020	1730	1720	1440
24 hr max. rainfall (mm	102	134	79	98
3 day max. rainfall (mm	143	187	126	153
Number of continuous days without rainfall (less than 0.1 mm)				
Rainy season	8	9	10	14
Dry season	12	16	18	26
Number of continuous days without rainfall (less than 5.0 mm)				
Rainy season	13	16	14	18
Dry season	24	31	31	44

(2) Runoff analysis

1) Water balance in the Yuna river basin

Using discharge data and estimated average rainfall at Villa Riva and El Limon, the water balance in the Yuna river basin was analyzed. Considering the influence of the Rincon and Hatillo dams construction, the analysis period was divided into 3 periods and the results were summarized as shown below:

	Period	Discharge (m^3/s)	Runoff (mm/year)	Rainfall (mm/year)	Runoff Coefficient
Villa Riva	1598~1978	84.7	570	1,596	36%
4,680 km^2	1979~1982	131.3	884	2,027	44%
	1983~1991	90.9	621	1,747	36%
El Limon	1969~1978	79.1	486	1,645	30%
5,130 km^2	1979~1982	135.5	833	2,057	40%
	1982~1993	98.7	607	1,763	34%

The amount of rainfall was relatively large in the period 1979-1982 and in proportion with it the discharge volume was increased in the same period. Observing the discharge pattern it is revealed that the runoff coefficient of the Yuna river after completion of dams became higher in three months (February, June and December) than that of the situation without dams; in particular, the runoff coefficient in February - the driest month of the year, was duplicated.

2) Low flow analysis

Based on the mean daily discharge data at Villa Riva and El Limon, the annual mean and minimum discharge were analyzed probabilistically and the result is shown as follows:

Villa Riva Catchment Area 4,630 km²				
Return period	Mean discharge (m³/s)		Minimum discharge (m³/s)	
	Before	After	Before	After
1/2	80.15	91.97	11.42	22.19
1/5	60.29	74.95	6.75	16.05
El Limon Catchment Area 5,130 km²				
Return period	Mean discharge (m³/s)		Minimum discharge (m³/s)	
	Before	After	Before	After
1/2	74.38	100.10	12.98	26.39
1/5	64.52	83.90	8.34	16.68

Note : Before and After Dam Construction

Based on the daily mean discharge data at Abadesa and the relationship between the specific discharge and catchment area, the annual mean discharge and the minimum discharge at Abadesa and the diversion point at the Payabo river were analyzed probabilistically as shown below:

Return period	Abadesa		Diversion point at Payabo	
	Mean discharge (m³/s)	Minimum discharge (m³/s)	Mean discharge (m³/s)	Minimum discharge (m³/s)
1/2	8.80	0.85	12.57	1.46
1/5	6.64	0.53	9.49	0.98

As for the amount of spring water a detailed analysis is presented in the section 4.2 "Potentials on Development".

3) High flow analysis

Several flood protection works were carried out at Arenoso, located between Villa Riva and El Limon, during the period 1970 ~ 1992 and the flow capacity of the Yuna river has risen up after completion of the works. It is expected that the flow capacity has risen from approximately 600 m³/s to 700 m³/s. The difference in flow between Villa Riva and El Limon has flown to Caño Gran Estero in the Flood Period. Therefore, the limitation of maximum discharge at El Limon depends on the flow capacity at Arenoso and that was estimated in approximately 750 m³/s from the discharge record. The result of the probability analysis for the high flow at Villa Riva and El Limon was summarized as shown below:

(m³/s)

Return period	Villa Riva		El Limon	
	Before	After	Before	After
1/2	630	670	470	530
1/20	1060	930	630	750
1/100	1280	1060	-	-

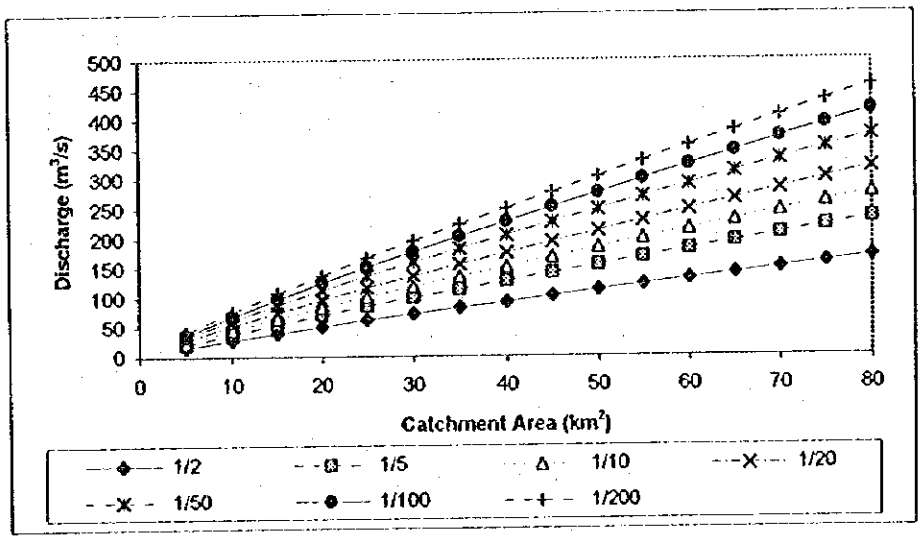
Note : Before and After Dam Construction

Based on the daily mean discharge data and the relationship between the maximum specific discharge and catchment area, the high flow at Abadesa

and diversion point at the Payabo were estimated probabilistically as shown below:

Return period	Abadesa Max. discharge (m^3/s)	Diversion point at Payabo Max. discharge (m^3/s)
1/2	180	200
1/20	380	420
1/100	500	550

Using the Rational formula and the 24 hr maximum rainfall, the flood discharge in the Study area caused by the direct runoff from the rainfall was estimated as shown below:



4) Sediment analysis

Using equations and daily mean discharge data, sediment runoff at stations mentioned below was estimated. The sediment runoff at the Payabo river was also estimated based on this result. The result was summarized as shown below:

- Villa Riva 290 $m^3/km^2/year$
- El Limon 260 $m^3/km^2/year$
- Abadesa 200 $m^3/km^2/year$
- Payabo 200 $m^3/km^2/year$

3.3 TOPOGRAPHY AND GEOLOGY

3.3.1 Topography

The area is surrounded by mountains more than several thousand meters high; to the north the Septentrional mountain range and to the south the Central and Oriental mountain ranges. These mountains gradually ascend from west to the east. In the vicinity of the study area they are only about 100-300 m. The study area itself is on a low lying alluvial plain about 5 - 20 meters above sea level, situated in between these mountains and formed from the deposits of the Yuna River, Payabo River, and Cevicos River which flow eastward. With a gradient of 1/1000, the area descends in the direction of the Samana Bay.

The south of the study area is bordered by the Los Haitises Range where a karstic foundation region is found. A precipice originated by fault developments separates these two areas.

3.3.2 Geology Features

The study area is geologically divided into the northern mountains and southern mountains. The former is made up of metamorphic rocks, which are distributed on the northern side of the Nagua River, intercalated with composite Cretaceous rocks. The latter is made up of the La Tabela and Las Sombrerito formations from the lower Eocene to the Middle Oligocene epochs. The southern slope of this mountain is distributed with Lagurabo formations of the Pliocene to the Pleistocene epochs.

These metamorphic rocks mainly consist of amphibolites and gneiss. The La Tabela formation and Las Sombrerito formation are mainly made up of conglomerates such as limestone, shale, andesites and sandstone. The La Gurabo formation is mainly made up of the stratification bedding plane layers of shale, tuff, and sandstone. The northern side of the study area is basically made up of metamorphic and composite rocks.

Composite Cretaceous rocks widely distributed in the upstream area of the Yuna River make up the basement rock layer of the southern mountains. Limestone and calcareous sandstone of the Pliocene and Pleistocene epochs make up the Los Haitises mountains to the south of the study area.

Tertiary volcanic rocks distributed in the upstream area of the Yuna River, limestone that form the Los Haitises Range, and the metamorphic rocks of the northern area all constitute the basement rock layer of the study area. Overlying this basement rock is a layer of Quaternary diluvial thin gravel, sands and clay, which in turn is overlain by alluvial sediments of the Yuna and Payabo rivers. The alluvial sediments are from the Holocene epoch and mainly consist of clay and sand.

The geological map of the study area is in Figure 3.3.1.

3.3.3 Geo-technical Survey

(1) Field survey

The following surveys were carried out in the course of the field survey.

1) Exploratory boring

The exploratory boring was carried out in the following manner:

- Boring pit: 10
- Boring depth: 10 - 24.5 m; 163.05 m in total
- Standard penetration tests: 120 nos. (each 1.5 m depth)
- Number of undisturbed samples: 11

2) Test pit

With assumption that a disaster prevention dam would be constructed within the Study area, the survey on materials which may be used for dam construction was made as mentioned hereinafter.

Two (2) types of soil material from the two borrow pits were selected based on the field survey results: soil consisting of flood sediments of the Payabo River, distributed in the vicinity of the study area, and soil made up of weathered limestone, namely Caliche, which is usually used as an embankment material of roads in the vicinity.

3) Laboratory soil testing

The undisturbed samples from the boreholes and the samples taken from the borrow pits were analyzed in a laboratory in relation with the following items.

Physical Property Test

. Specific Gravity
. Water Content
. Grading Analysis
. Allerbert's Limits
. Unit Weight

Mechanical Property Test

. Triaxial Compression (UU)
. Consolidation
. Compaction

(2) Study Results

1) Exploratory Boring

The exploratory boring results are shown in the following table.

Geological Period	Epoch	Symbol	Soil Quality	Thickness of Layer (m)	N-Value	Average N-Value
Quaternary	Alluvium		Gravely Clay	0.8		
		Bs	Clay	-	3 - 17	8
			Sandy Clay	0.5		
		Ac	Clay-Sandy Silt	2.0-18.0	2 - 20	5
		As	Sand	3.0	10 - 41	27<
		Ag	Gravel	2.0-4.0	37 - 50<	50<
	Diluvium	Dc	Clay	-	13 - 50<	28
		Ds	Sand-Clayey Sand	3.0-4.0	42 - 50<	50<
		Dg	Gravel	-	50<	
Tertiary	Pliocene	Tc	Clay	-		46

As indicated in the geological profile, the ground foundation in the study area is divided into 8 layers.

a. Topsoil (Bs)

The topsoil in the study area is mainly used for the banking of roads and rivers. Caliche, weathered limestone, is usually used for road embankments, while river levees are formed of clayey soil.

b. Alluvium

The alluvial layer is made up of sub-layers of clay, gravel, and sand.

The clay sub-layer is distributed over the entire study area. It is 20m thick in the vicinity of Ponton pond, averages about 10 m thick from Los Cocos to the Cevicos River to the west, and is 13 m at the Payabo River.

The thickness of this sub-layer increases in the northerly direction from the downstream section of the Arrenquin canal. But it is only 3 - 7m from Los Cocos to the direction of the Cascarilla drainage canals to the east. The N value ranges from 2 - 20, averaging 5.

The distribution of the sand (As) and gravel (Ag) sub-layers were investigated at the Arrenquin canal and Los Cocos area. The sand layer is made up of homogeneous fine sands, while the gravel layer mainly consists of rounded gravel. The N value in the sand layer ranges from 10 - 41, averaging 27, and 37 to more than 50 for gravel.

c. Diluvium

The diluvial layer consists of three sub-layers: clay, sand and gravel.

The clay of this layer is distributed over the whole study area, except in the Cevicos River site, and is overlaid by the clay sub-layer of the alluvial deposits. The clay in this layer is extremely hard with an N value ranging widely from 13 to more than 50; averaging 28.

The terrain is undulating and sedimentary changes are quite irregular due to the erosion and inundation brought about by the rivers Cevicos, Yuna and Payabo. In particular, a deep gorge has developed in the vicinity of the Ponton pond at the mouth of the Payabo River.

The sand layer (Ds) is evenly distributed in the Payabo River area and partially intercalated with clay. The N value has a narrow range, from 42 to more than 50.

The gravel layer (Dg) lies underneath the sand layer in the Los Cocos area. Gravel in this layer is round and measures 5 - 20 mm. The N value is more than 50.

d. Tertiary Pliocene

Clay (Tc) of the Tertiary Pliocene is restricted to the western end of the study area, the Cevicos River area. The core of this layer is made up of reddish brown clay. Underlying this layer is the basement rock that along with limestone constitutes the Los Haitises mountain. This basement rock layer has become clayey due to weathering. The limestone rock layer is mixed with a lot of gravel.

Caliche is the soil material most commonly used for road embankment in the study area.

2) Laboratory Test Results

The results of the analysis on the undisturbed samples and the samples of embankment materials are as shown below. The details are summarized in Appendix C.2.

a. Undisturbed samples

a). Physical characteristics

The gradation curve of alluvial clay in Fig. 3.3.6 shows that more than 80% of the alluvial clay is made up of fine grained soil (silt and clay). The consistency properties of this clay type: liquid limit (WL) of 39 - 50 %, plasticity limit (Wp) of 20 - 24 %, plasticity index (Ip)

of 19 - 29. These figures are classified under "CL" in the plasticity chart.

Soil density (ps) was observed at 2.43 - 2.65 g/cm^3. The natural water content (*Wn*), 15 - 42 %, was considered low for a clay layer. Wet density was measured at 1.77 - 1.89 g/cm^3.

b). Mechanical Properties

Although the values range widely, the average cohesion, c = 0.90 kgf/cm^2 led to the conclusion that the angle of internal friction (∅) is O.

Although the values vary widely, consolidation shearing strength was found to increase with depth, a condition that exceeds the limits of the effective overburden pressure (ov). Therefore, clay in this layer is considered to be excessively consolidated with an average overconsolidation ration of 2.

b. Embankment material

a). Physical properties

The gradation curve of embankment materials shown in Figure 3.3.11 indicates that 64% of Tp-1 is gravel and 24% is sand. On the other hand, Tp-2 is considered clayey as it is 80% fine grained soil (silt and clay).

The consistency properties are: liquid limit (WL), 34 - 39 %, plasticity limit (Wp), 18 - 21 %, and plasticity index (Ip), 16 - 18. These figures are classified under "CL" in the plasticity chart.

Soil density (ρs) ranges from 2.60 - 2.67 g/cm^3 and natural water content (Wn) is 18% for Tp-1 and 29% for Tp-2.

b). Mechanical properties

The compaction test on embankment materials has disclosed that the maximum dry density (ρ dmax) of 1.927 g/cm^3 and an optimum moisture content (Wopt) of 12.0% were obtained for "caliche (limestone)" and the maximum dry density (ρ dmax) of 1.531 g/cm^3 and optimum moisture content (Wopt) of 23.0% were obtained for flood sediments, respectively.

The results of the compaction test shows that compaction takes place when the maximum dry density is 95%. A Triaxial compression test was then carried out on the compacted materials.

The shear strength of the materials used are shown below.

Borrow Pit	Shear Strength	
	Cohesion (kgf/cm^2)	Angle of Internal Friction (°)
Caliche	0.4	3
Flood Sediments	0.6	8

3.4 SOIL SURVEY AND SOIL CLASSIFICATION

3.4.1 Brief Review on Soil Features in the Dominican Republic and the Study Area

A detailed soil survey related with the Study area was carried out by FAO from 1974 to 1975, and the results obtained were published in the report: "Los Suelos del Bajo Rio Yuna Mapeo, Clasificacion y Aptitud para los Cultivos", 1976. The content of the report can be summarized as follows:

In the alluvial plain of the Yuna river, clayey soils including their related ones which are suited for rice cultivation are distributed dominantly on the lowland, while loamy soils which are apt for planting of banana, cacao and coconut palm are concentrated on the terrace. The soils derived from peat or muck lie also in some places.

3.4.2 Soil Survey

(1) Field survey

Field survey for reconnaissance of soils in the Study area and sampling of soils for laboratory analysis were conducted. Sites of the survey were selected under utilization of references, aerophotos (1:20,000) and topographical maps (1:10,000), and most sites were confirmed by using GPS.

1) Boring spot test with soil auger

Prior to observation of soil profile, boring spot test was done by using the soil auger. As a result of the test, effective depth, texture, color, contents of the big fragments such as gravel and stone, etc., of soils were known. Furthermore, slope of land surface, biological state, drainage condition, degree of humidity, aspect of erosion and erodibility were observed.

2) Observation of soil profiles in excavating pits

The observation and description about soil profiles were executed within excavating pits. The procedure of observation was done with the "Soil Survey Manual No.-18 (USDA)" and other supplemental manner of the Dominican Republic. At an average rate of one pit per six hundred ha, twenty two pits were dug in total, and on each profile, horizon sequence,

effective depth, texture, structure, consistency, plasticity, gravel and stone content, color, hardness, ground water level, root spread, drainage, etc., were observed and recorded. Furthermore, distribution of gravel, rolling stones or bare rocks, landscape, land slope and vegetation were recorded. The sites of master pits are shown in Fig. 3.4.1.

3) Sampling

Sixty one bulky samples of the soils were taken from the representative horizons on the profile of each excavating pit and sent to the "Laboratory" of the above mentioned "Seccion" to be analyzed.

(2) Laboratory analysis of soil samples

The soil samples which were sent to the laboratory were analyzed on physical and chemical properties by INDRHI. Items and methods which have been employed are as follows:

1) Physical properties;

- Particle-size distribution
- Water content at permanent wilting point (Pressure membrane method at 15 bar)
- Real specific gravity (Pycnometer method)
- Field capacity (Pressure membrane - unglazed disk method at 1/3 bar)
- Bulk density
- Saturated water capacity
- Content of particles larger than 2 mm = Gravel content

2) Chemical properties

- pH and EC of saturated pastes
- Content of soluble cations and anions
  Ca^{+2} and Mg^{+2}: Titration with EDTA
  Na^{+} and K^{+} : Atomic absorption spectroscopy
  CO^{-2} and HCO_3^{+} : Titration with acid
  Cl : Precipitation with $AgNO_3$
  S : Using Spectronic-20, precipitating as barium sulfate
- Exchangeable ions
  Extraction with ammonium acetate solution, formaldehyde method and atomic absorption spectroscopy
- Organic matter content : Walkley and Black's procedure
- $CaCO_3$: Gas analysis
- Trace elements : Atomic absorption spectroscopy
- Phosphorus, nitrogen, boron, and sulfur: Using Spectronic - 20 with a photoelectric tube and an infrared filter.

3.4.3 Soils Survey Result

Almost two decades has passed since FAO completed their survey, therefore it is supposed that the properties and distribution pattern of the soils in the Study area might have shown some transformations to have been affected by frequent attacks of flood and by construction of engineering works for irrigation and drainage during the period. The purpose of this phase of the Study is to verify whether the above-mentioned transformation appears on the soils or not.

(1) Creation of new soil series and preparation of new soil map

The soil description and analytical data to have been revealed as a result of the Phase I field works are compiled in the Table D.3.1 (1) - (22).

It was confirmed that there was no fundamental transformation of soils between those distributed at the time of FAO survey and those existing at present. However, in some places, an additional sedimentation composed of relatively new soil materials such as clay and silt that would have been brought in by flood for many years and the drying tendency of the meadow soils by artificial drainage were observed.

On the basis of such verification, twelve soil series have been created by the Study Team with transferring a part of the former soil series which had been established by the FAO survey team. Lists of newly created soil series and of accordingly corrected former soil series are given in Tables 3.4.1 and 3.4.2, respectively. And, in conformity with the present soil survey, new soil map of the Study area is prepared as shown in Fig. 3.4.2.

(2) Distribution of soil series

The soil types of which the distribution has been confirmed by the present soil survey are as follows:

According to a classification system of Soil Taxonomy, a lot of soil units that fall into five orders of Vertisols, Inceptisols, Mollisols, Alfisols, and Histosols, and three associations of Inceptisols/Mollisols/Entisols, Inceptisols/Histosols, and Inceptisols/Vertisols occurs in the Study area.

A range of relatively young soils - Inceptisols occurs dominantly in the background of the Yuna river's bank, a mixed type of soil - Inceptisols/Mollisols/Entisols in the western district along the shore of the Yuna river, the soft soils - Mollisols in the district between the Yuna river and the Payabo one of the western part, a kind of the soils rich in swelling clay minerals - Vertisols in the central district, a group of soils rich in iron and aluminum constituents in the surrounding district of the Vertisols' zone, the peaty soils - Histosols in the southeast part, a class of combined soils - Inceptisols/Histosols in the vicinity of the Histosols' zone, and a group of mixed soils - Inceptisols/Vertisols in the coast of the Barracote river.

3.4.4 Land Capability Classification

The soil series newly created in the present survey were assessed their capability for irrigation use in accordance with Aren's classification system. The results obtained are shown in Tables 3.4.1 and 3.4.2, respectively.

And, land capability classification map for irrigation is given in Fig. 3.4.3.

According to the criterion of the land capability classification for irrigation, the lands graded into five classes occur in the Study area, that is, class 1 having no limitation and being suitable for irrigation to produce the high yield of all sorts of crops that suit to the local climate; class 2 having some limitation of soil, topography and drainage and being suitable for irrigation to produce the high yield of limit sorts of crops; class having severe deficiencies of soil, topography and drainage and being suitable for irrigation to produce moderate yield; class 4 having greater limitation of soil, topography, drainage, economy and flood and being unsuitable for irrigation to produce the most of crops with exception of rice and hygrophytes; class 5 being unsuitable for irrigation though additional survey is required for final decision.

The soils of classes 1 and 2 occur in the districts between the Yuna river and the Payabo river in the west part and on the bank of the Yuna river in the parts from north to northeast, the soils of class 3 in the parts of central south and of east, the soils of class 4 in three parts of northwest, center and southeast, and the soils of class 5 in the coastal of the Barracote river in the southeast part and in the central east part.

3.4.5 Consideration on Future Land Use on the Basis of the Soils Survey

The lands lying between the Yuna river and the Payabo river in the east part are suitable for irrigation cultivation of not only rice but also upland crops such as maize, banana, beans, tomato, cabbage, etc. because of their better drainage.

The lands of class 3 which are found in the central south and east parts are deficient in drainage, therefore, they will become arable well for paddy rice if the drainage canals are constructed. In the lands of class 4 which occur in the central part, the high yield of rice may be expected owing to their rich content of swelling clay minerals after completion of drainage canals.

The lands of class 5 are formed with the soils derived from peat and peat materials, so in addition to the construction for irrigation and drainage, the enforcement of some kinds of technology such as land improvement, soil management and cultivation practice is required. On the whole, besides the construction of effective irrigation, it is desirable to implement the measure against inundation and the drainage construction for widely spread clayey low-lands.

3.5 LAND USE AND LAND TENURE

3.5.1 Land Use

(1) Previous land use

Consulting the topographic map elaborated in 1967, the following facts are revealed regarding the land use before the commencement of the settlement project in Limon del Yuna area.

a. There already existed a lot of villages along the Yuna river just in a similar condition as they are at present.

b. The extension of cacao plantations around villages are larger at that time than that of the actual situation.

c. About 600 ha of the paddy fields were developed on the western side of the Study area, where the Payabo river flows into the plain from mountain area.

d. About 6,000 ha of wetlands were extended in front of the Los Haitises range.

On the other hand, the aerial photographs taken in 1984, 17 years after the aforesaid-mentioned elaboration of the topographic map, indicate the following transformation in the land use of the area.

a. There were some extension of uplands in the vicinity of the actual forests surrounding residential areas, but look like at present as if they were forests for having been left in fallow for long period.

b. In considerable portion of lands which are actually used as pasture and uplands paddy was cultivated ten year ago. Poor drainage of these lands has driven this conversion.

(2) Present land use

The agrarian reform project has developed nuclear villages such as Guaraguao, Barraquito and Paraguay and surrounding lands of these villages have been exploited as paddy fields.

Present land use survey in the Limon del Yuna area was made during the field survey referring to the topographical map (1/10,000) and an interpretation of aerial photographs (1/40,000) and the result of this survey is summarized as follows:

Land Use Category	Area (ha)	%
1. Arable Land	9,350	77.9
1.1 Paddy field	6,680	55.7
1.2 Upland	490	4.1
1.3 Pasture	2,180	18.2
2. Forest	1,410	11.8
3. Wetland	80	0.7
4. Wasteland	20	0.2
5. Pond	60	0.5
6. River	130	1.1
7. Settlement	290	2.4
8. Others	660	5.5
Total	12,000	100.0

Paddy fields have a majority over others in land use accounting for 56% of the total area and 71% of the arable land. The category of forest comprises lands occupied by cacao and coconut palm trees, uplands, bush, and so on, thus approximation of this extension is somewhat difficult. Pasture endowed with better drainage are used for intensive animal husbandry, whereas poorly drained pasture are used extensively. In general, uplands are located where have higher land elevation without having access to irrigation water and have been developed for large scale plantation of plantain; uplands are taken into account only when their block exceeds 10 ha, thus an actual extension of uplands including those dispersed throughout forests may be twice as large as that presented in the above table

(3) Grade of development of paddy parcel

The revised map, which was elaborated through interpretation of the aerial photographs taken in 1984, indicate boundary of each parcel; paddy fields distributed by IAD show orderly rectangular of 100 m x 450 m or 100 m x 400 m and those of other holdings have irregular parcel forms. Field consolidation works have been undertaken by IAD up to date. Existing paddy fields may be classified into the following three categories by their parcels, namely:

Category A - Completely consolidated parcels:	2,570 ha (38%)
Category B - Fairly consolidated parcels:	1,800 ha (27%)
Category C - Parcel without consideration:	2,310 ha (35%)

3.5.2 Land Tenure

From the viewpoint of land tenure, the Study area is divided into the following three area:

a. : Limon del Yuna project area (7,800 ha): state-land
The right side of the Payabo river except the private area.

b. : Private area (800 ha): private land
The northeastern side in the Study area along the Yuna river.

Since an approximate 800 ha out of the total Villa Riva area is under the control of IAD, in total approximate 70% of the Study area is under the control of IAD.

Based on the water charge ledger of INDRHI, scale of the land holding in the Study area is classified as follows:

Farm Size (ha)	IAD'S AGRARIAN REFORM				PRIVATE LAND				TOTAL			
	No. of Farmland	(%)	Accumulative Area	(%)	No. of Farmland	(%)	Accumulative Area	(%)	No. of Farmland	(%)	Accumulative Area	(%)
0-1	6	0.5	4.32	0.1	9	2.9	7.82	0.4	15	1.0	12.14	0.2
1-2	33	2.9	57.43	1.3	53	17.2	88.58	4.4	86	6.0	146.01	2.3
2-4	1008	89.6	3148.59	70.9	99	32.0	299.19	15.0	1107	77.2	3447.78	53.6
4-6	36	3.2	148.17	3.3	24	7.8	114.27	5.7	60	4.2	262.44	4.1
6-12	10	0.9	89.54	2.0	76	24.6	557.80	28.0	86	6.0	647.34	10.1
12-25	20	1.8	355.85	8.0	40	12.9	626.25	31.4	60	4.2	982.1	15.3
>25	12	1.1	635.87	14.3	8	2.6	298.09	15.0	20	1.4	933.96	14.5
Total	1125	100.0	4439.77	100.0	309	100.0	1992.00	100.0	1434	100.0	6431.77	100.0

According to the information collected at BAGRICOLA's branch offices, out of the total farms in the Study area, about 23% (2,800 ha) are covered by private lands. Private lands are concentrated in the vicinity of the Yuna river, where farmers started to occupy before the commencement of the agrarian reform project. For the purpose of getting information on land holding of large farms survey by means of direct interview to farmers was carried out and it has disclosed their extension and land use in the following manner (The majority of owners of these large farms live out of the Study area).

a. Confluence of the Yuna river and the Payabo river

Mr. A: 187 ha; used for pasture
Mr. B: 125 ha; used for pasture
Mr. C: 25 ha; used for paddy field

b. Block between the Yuna river and the Cascarilla canal

Mr. D: 320 ha; used for paddy field and pasture
Mr. E: 106 ha; used for paddy field

c. Other blocks

Mr. F: 187 ha ; used for pasture and paddy field
Mr. G: 69 ha; used for paddy field
Mr. H: 44 ha; used for paddy field
Mr. I: 31 ha; used for paddy field.

As mentioned above, although settlers of the agrarian reform had been distributed their lands equally (around 4 ha) at the time of their settlement, in the course of 27 years after settlement some of the said distributed lands are divided among family members, and, as a consequence, an imbalance of land size among farmers has accelerated recently. Small farmers, without financial resources for getting agricultural inputs, are forced to leave their lands without crop, meanwhile large farmers tend to use their lands in an extensive manner. Under the circumstances, it is prerequisite to adjust the said imbalance of land size so as to attain more

appropriate O/M services at the time of turnover of irrigation system from INDRHI to the "Junta de Regantes" (water users' association).

3.6 SOCIO-ECONOMIC SURVEY

3.6.1 Introduction

With a view to disclose socio-economic feature of the farmers in the Study area, a survey was conducted in the course of the Phase I field work to cover a total of 117 families dispersed over 22 villages:

Major topics to have been sounded to farmers in the said survey are as follows:

- General information of interviewee (General characteristics of farmers)
- Residence and provision of social infrastructure
- Land use, cropping pattern, production and marketing of products
- Irrigation system
- Institutional supporting system to farmers (Credit, technical assistance, etc.)
- Rural organization
- Identification of problems on farming and marketing of agro-products

In addition to this survey, in view of the possibility to convert grazing lands into paddy fields with implementation of the Project, supplementary survey on cattle farming was carried out during the Phase II of the field works.

3.6.2 Social Features

The Limon del Yuna agrarian reform project was started in 1967 - 27 years ago, so farmers in the Study area are relatively old with an average age of 48 years. About one to every ten interviewed farmers was female. Regarding with education level of farmers, only 14% of them got education superior to the primary level and farmers who did not attend any school reach 26% of the total.

Major portion (62%) of the settled farmers came from the Province of Duarte, of which 80% had native place within Villa Riva municipality.

An average gross income per family RD$ 59,771.76/year, which was composed of RD$ 49,733.28 by agricultural and livestock activities and RD$ 10,038.48 by other activities.

In relation with the type of housing, only 10 of 117 interviewed farmers do not have their own house. Houses equipped with indoor faucet accounts for only one-third of the interviewees and about half of these interviewees' houses are not supplied electricity.

3.6.3 Land Tenure and Land Use

So far as the land tenure is concerned, the number of farmlands cultivated by 117 interviewees account for 130 in total (this means that there are 13 farmers who cultivate crops in two farmlands), of which 58% correspond to stall lands distributed by Dominican

government to beneficiaries of the agrarian reform. The farmlands cultivated by surveyed farmers, with an average size of 4.55 ha.

With regard to privately owned farmlands, there presents imbalance in terms of farm size by ownership; 17% of privately owned lands range larger than 12 ha, while 34% of these lands are smaller than 2 ha. By contrast, agrarian reform lands are, by their nature, characterized by their similar size (about 90% of them are concentrated in the range of 1-4 ha).

The Study area has been developed as an area for rice production, so paddy fields occupy the greater portion (67%) within the context of the land use and grazing lands follow with the coverage of 20%. Lands used for permanent and annual crops are insignificant with a proportion of 3.9% and 3.6%, respectively. Around 5% of the lands are left as fallow or idle lands without crops.

3.6.4 Farming Practice

Due to lack of financial arrangement as well as deficient access to irrigation water, not a total paddy fields filled with plants. It is revealed that the cropping intensity of paddy fields among interviewed farmers remains relatively low: 70% for the first cropping semester and 53 for the second cropping semester.

The unit yield of paddy among interviewed farmers was 3.75 ton/ha. Approximately 16% of the harvested rice is consumed by farmers and their family members. The proportion of the harvested rice which are sold within the Study area was 57%.

So far as livestock is concerned, cattle farming is the leading activity, while swine and poultry are bred in small scale, mostly to support household economy of farmers who engage in crop production. The great majority of animals are sold within the Study area from farmers to middlemen.

Almost all interviewed farmers answered that cultural activities relevant to crop production are done by both farmers (including their family members) and hired labors; an average number of persons who work at fields are: 2.2 (family member) and 13.2 (hired labor).

The average wage paid to hired labor was around RD$ 100/day.

91% of farmers who were interviewed depend on their farming activities on machinery and/or equipment and 81% of them use animals, meanwhile only 9% of the interviewees carry out crop cultivation using exclusively manpower.

Regarding irrigation system, 88% of the interviewed farmers had access to irrigation water, and 31% of them take water to irrigate their paddy fields by means of pumping system. As for sources of irrigation water, 36% of farmers intake water from rivers, 56% from canals, and 3% for wells.

3.6.5 Institutional Supporting Services to Farmers

According to the survey to farmers, about 30% of farmers could not get credit needed to purchase agricultural inputs. On the other hand, of farmers who got credit services, 84%

were from the Agricultural Bank (BAGRICOLA) and 15% were from sources other than banks such as rice mills, relatives, etc.; only one farmer among the 117 interviewees got credit from commercial bank.
The extension services or transfer of technology from governmental officials to farmers is an important factor if farmers desire to attain sustainable crop production as well as higher level of yield.

Nearly half of the farmers in the area had experience in participating some training course on cropping technology. In addition, 87% of them received technical assistance services either from governmental officials or private experts and 72% of them evaluated these technical assistance services to be useful. The fields on which more farmers received technical training or extension services were: Insects and disease control and weed control.

The Government of the Dominican Republic encourages rural population to participate any kind of organization and in line with this promotion, 72% of the interviewees belong to some organizations. The major reason why farmers in the Study area are affiliated with association and/or cooperative is that settlers without land ownership confront difficulty in getting finance for their farming activity if they are not member of any association or cooperative.

3.6.6 Identification of Problems on Crop Production and Marketing; Intention of Farmers

The interviewed farmers identify problems related with their farming practice in the following manner.

IDENTIFICATION OF PROBLEMS	AFFIRMATIVE PERCENTAGE
1. Elevated price of inputs	95
2. Access to credit	91
3. Acquisition of quality seed	83
4. Limited farm size	75
5. Availability of inputs	74
6. Irrigation system	52
7. Technical assistance	50
8. Availability of irrigation water	50
9. Lands inundation	32
10. Labor force	20
11. Profitability of crop production	17
12. Land fertility	14

On the other land, problems concerned with marketing of agro-products are posed as figured below.

IDENTIFICATION OF PROBLEMS	AFFIRMATIVE PERCENTAGE
1. Drastic fluctuation of farm-gate price	94
2. Prolonged period for payment	73
3. Transportation method	65
4. Negotiating capacity with buyers	65
5. Lack of processing facilities	56

Despite the said problems prevail, the great majority (93%) of the surveyed farmers in the Study area intend to continue to cultivate their farming activity with actual crops, because: 1) Better accessibility to credit service, 2) Familiarity with cropping technique, 3) Adaptability of soil condition, 4) Lack of information and technical assistance on other crops, and so on. Nearly four-fifths of the interviewees answered that they are satisfied with the actual crops, simply because they live at least on them.

3.7 AGRICULTURAL PRODUCTION

3.7.1 Outline of Agriculture

(1) Rice production

According to an investigation of the Study Area's 12,000 hectares, paddy fields account for 6,680 hectares — IAD settlements make up 4,380 hectares and privately owned lands 2,300 hectares. From information obtained on financial credit given to farmers and a survey on farmers' socio-economic condition and the field reconnaissance survey, the total area of land cultivated in the Study Area each year is estimated to be 9,500 hectares; 6,000 hectares undergoes first cropping of which 3,500 hectares has a second cropping. The yield per hectare as calculated by quadrat sampling and assumptions obtained from investigations was 3.9 tons/ha for the first crop and 2.6 tons/ha for the second crop. Consequently, it is broadly calculated that the Study Area produces 32,500 tons of rice yearly. The potential irrigated lands were predicted to be around 7,860 hectares as a result of the field reconnaissance survey and measurement.

(2) Upland crop production

Cultivation is also carried out in the uplands along the Yuna River. Perennial crops such as cacao, plantain and coconuts are predominant, although sweet potatoes, cassava, maize, haricot beans and vegetables (pumpkins, sweet peppers, cucumbers, etc.) are cultivated as well. Due to undulations, 10 to 30 hectares of upland fields planted with tubers, pulses and vegetables are scattered in the paddy field zone. The harvested area, production and yield of these upland crops are shown in Table 3.7.1.

(3) Livestock production

The slightly elevated areas in the southern half of the settlement area are used as pasture. Each settler is generally allotted 60 tareas (3.8 hectares) of land on which they use to graze 10 - 15 cattle. These cattle are generally for dairy and meat production. There are also privately owned pastures of up to 700 hectares on the northeastern and north-central parts of the Study Area where cattle-raising is comparatively productive. According to the results of a survey on livestock, graziers hold 2,180 hectares of the Study Area; average pasture land per grazier is 9.0 hectares with the average number of head being 7.1.

3.7.2 Farming

(1) Rice culture

1) Cropping system

The fundamental rice cropping system in Limon del Yuna is as follows:

First cropping:	Seeding in nursery in December
	Transplanting in January - March
	Harvesting in May - July
Second cropping:	Seeding in nursery in May - July
	Transplanting in June - August
	Harvesting in October - December

The weather in the area is not an impediment to year-round rice planting activities as the monthly temperature suits this cultivation practice. Rather, it is influenced by the availability of irrigation water and the availability of funds.

The rice cultivation practice that predominates is transplanting; transplanting of rice seedlings is carried out on 80% of the fields while direct seeding is carried out on the remaining 20%. Generally the yield for transplanting and direct seeding is about the same, however, in the Study Area because of inadequate field leveling the yield for direct seeding is lower.

2) Working system

Nursery bed: Nursery beds are 1 meter wide, 10 - 20 meters long, and are surrounded by a drain. They are seeded with 110-150 g/m² of rice seeds which were soaked for 1.5 days and dried in the shade for half a day to induce sprouting. Nursery beds of 100 m² produce enough seedlings for paddy fields of 2000 - 2500 m². Fertilizer is generally not applied.

Paddy field preparation: Plowing is generally carried out either by a rotary tiller or draft cattle. Leveling is also carried out in the same way using a leveling board. These works are carried out by contractors. Large scale land owners use tractors for rotary tilling and leveling. Manual leveling works and manual construction of small levees for water depth control are carried out by the farmer himself if deemed necessary.

Transplanting: The number of stocks generally planted per square meter is 40 - 45, though CEDIA recommends a density of 16 - 20 stocks per square meter. Ropes or any other standard method of measurement are not used when planting. Transplanting work including the uprooting of seedlings is carried out at a rate of 0.09 - 0.12 hectares per laborer per eight-hour day.

Fertilizer application: 290 kg/ha of compound fertilizer "15-15-15" is applied a week after planting. In addition, 50 kg/ha of urea is applied at the young panicle formation stage.

Weeding: Herbicides are sprayed 2 - 3 days and 1 month and a half after transplanting. Further, manual weeding of barnyard millet and wild rice is also carried out if necessary. Aside from the spraying activities carried out by the farmers, aerial spraying companies can also be hired. This is done at a rate of 11.5 hectares per hour.

Plant protection: Rodents are considered the most dangerous animals. Though rodenticide is used it is not a sufficient deterrent. While the most harmful insect pest is the Rice Cut Worm also called Gusano (*Spodoptera litura*), damage caused by the Southern Green Stink bug or Hiedevivo (*Nezara viridula*) and Rice Whorl Maggot (*Hydrellia philippina*) are occasionally detected as well. Of harmful diseases the most destructive is Blast (*Pyricularia oryzae*), while Brown Spot (*Cochliobolus miyabeanus*) and Cercospora Leaf Spot (*Sphaerulina oryzina*) have also often been detected. Aside from the spraying activities carried out by farmers, companies specializing in aerial spraying are also hired.

Harvest: More than 95% of the area's entire paddy fields are harvested using combine harvesters from either the Federacion Agraria de Limon del Yuna or private contractors. The farmers work ends after the sacks of unhulled rice are delivered for marketing. The transport and drying activities are undertaken at the rice mills.

3) Varieties

Juma 57 and Isa 40 make up about 90% and 10% respectively of the entire rice grown in Limon del Yuna. Juma 57 is a good quality and high yielding variety evolved from the hybridization of Milo and IR8. Thirty (30) days is said to be the ideal period for rice seedlings to remain in the nursery, although even if they are left in the nursery for 60 days normal growth will result after transplanting. The total time from transplanting to ripening varies according to season due partly to photoperiodic sensitivity. Growing time is 125-130 days for the first cropping and 115-120 days for second cropping. Yield in the second cropping also varies between 20-50% lower (average 35%) than the first cropping.

4) Paddy yield and land classification

Surveys were carried out in both cropping seasons. Lands were classified in the Study Area for rice production, based on the quadrat sampling yield survey and the proposals by the technical personnel from the IAD and SEA whose estimates were based on years of experience (see Fig. 3.7.1). Current rice yield and area of paddy fields in respective class are as follows;

Class	Current Yield		Current Area
	1st Crop.	2nd Crop.	
Class 1	4.5 t/ha	3.1 t/ha	2,450 ha
Class 2	4.0	2.6	3,080
Class 3	2.5	1.6	1,150
Total	3.9*	2.6*	6,680

* weighted average

In addition, estimation of the yearly yield for the double cropping system was carried out. As a result, the best cropping seasons for maximum yearly yield are understood as follows;

Cropping season	Transplanting time	Harvesting time
First cropping	from Early Jan. to Early Mar.	from Early May to Mid July
Second cropping	from Early July to Early Sept.	from Late Nov. to Late Dec.

(2) Upland crop cultivation

1) Cacao

The cultivation of cacao trees is considered profitable because they continue to produce beans several years to several decades after they have been planted. Cacao trees need little care and have an estimated annual yield of 700 - 1000 kg/ha. Although the climate, over 2000 mm/year and an average daily temperature of 25 degrees centigrade, is favorable the actual yield is less than 700 kg/ha due to a lack of good new varieties. However, the introduction of good quality and high yielding varieties is possible through the guidance of the Centro Nacional de Desarrollo Tecnologico del Cacao (CENDETECA), an agency with holdings of comparatively excellent varieties.

2) Vegetables and edible crops

Maize, cassava and sweet potatoes are the major crops, followed by haricot beans (*Phaseolus vulgaris*), pumpkins and yautia (*Xanthosoma sagittifolium*). Other vegetables such as sweet peppers, cucumbers, eggplants, and pigeon peas are cultivated as well.

There is no fixed cropping pattern. The cultivation of non-seasonal crops is continued as long as they are harvestable, then they are replaced by other more suitable crops. The cultivation period of major crops is as follows:

Crop	Period from seeding to harvesting	Harvest period	Main seeding season
Sweet peppers	2.5 months	3 to 5 months	non seasonal
Cucumbers	1.5 months	1 month	non seasonal
Eggplants	2.5 months	4 to 5 months	non seasonal
Pumpkins	2.5 months	2 to 2.5 months	Oct. to Nov.
Tomatoes	3 months	1 to 2 months	Sept. to Oct.
Haricot beans	3 months		Nov. to Jan.
Maize	3 to 4 months		Oct. to Nov.
Sweet potatoes	6 to 7 months		May and Oct.
Cassava	7 to 9 months		non seasonal

Pigeon pea is seeded in February, harvested in December, and starts growing back in the following March.

(3) Livestock farming

1) Pasture

The IAD's settlement plan intends to use the slightly elevated and fertile area along the Yuna River for upland crop cultivation. It also plans to use other areas for rice cultivation as much as possible, while areas considered unsuitable will be used for grazing.

2) Cattle breeding

Generally, each settler is allotted 60 tareas of land (3.8 hectares), which they usually use to graze 10 - 15 heads of cattle. The lands are usually divided into three parts whereby a 10 - 15 day grazing period is carried out on a rotational basis according to the condition of the grass. Most of the cattle are for milk and beef production; milk is sold to the market, while generally cattle for beef are sold when they reach 15 months, to the market. Some farmers only sell the milk, keeping the cattle as insurance for rainy days.

There are also privately owned pastures of about 700 ha in the northeastern and north-central parts of the Study Area where cattle-raising is relatively productive. The following are the results of a survey of graziers who own lands totaling 2,180 ha of the Study Area:

- Average pasture area: 9.0 ha
- Percentage of improved pasture: 48 %
- Number of heads per hectare: 7.1 heads/ha
- Weight at weaning: 62 kg
- Interval between delivery: 15 months
- Milk yield: 5.4 liters/day/head
- Lactation period: 177 days
- Fattening rate: 600 grams /day

3.7.3 Agricultural Output and Value

(1) Crop production

Making reference to the information on the harvested area and unit yield presented in the previous section, the output of crops for the year of 1994 to cover the whole Study area is resumed as shown in the table below.

Crops		Harvested Area (ha)	Unit Yield (ton/ha)	Output (ton)
Paddy	1st Crop	6,000	3.9	23,400
	2nd Crop	3,500	2.6	9,100
	Sub-total	9,500		32,500
Perennial crops	Cacao tree	500	0.67	335
	Plantain	610	6.4	3,904
	Coconut palm	250	10.0	2,500
	Sub-total	1,360		6,739
Annual upland crops	Maize	100	1.0	100
	Sweet potato	50	5.1	255
	Cassava	50	5.1	255
	Haricot bean	12	1.3	16
	Vegetables*	30	6.3	189
	Sub-total	242		815
Total		11,102		40,054

Note: * Represented by pumpkin, cucumber and sweet pepper

The paddy absorbed more than 80% of the total output in the Study area, while perennial crops occupied approximately 17% of it. So far as annual upland crops are concerned, because cultivation for respective crop is small in area and capricious with less advanced technology, their productivity remains inferior to the national average and the sum of their output narrowly exceeded 2% of the total output of the Study area.

(2) Livestock production

The major production in the area is beef and milk and their output was estimated according with the survey result to local farmers together with information provided by IAD, BAGRICOLA and other relevant sources.

1. Milk production: Pasture area x carrying capacity of cattle per area x unit productivity (//head/day) x annual duration period for milk production
   = 2,180 ha x 2.6 heads x 5.41 / x 177 days
   = 5,428,000 liters

2. Beef production: Heifer and steer: Pasture area x head per area
   = 2,180 ha x 1.45 head = 3,161 heads
   Cow: pasture area x head per area

2. Beef production: Heifer and steer: Pasture area x head per area
= 2,180 ha x 1.45 head = 3,161 heads
Cow: pasture area x head per area
= 2,180 ha x 0.5 head = 1,090 heads

(3) Crops and livestock production value

With data on output and farm-gate price (refer to the section 3.8 - Marketing and processing of agro-products), the crops and livestock production value was roughly estimated as summarized in the following table.

Crops	Output (Ton)	Price (RD$/ton)	Value (RD$)	%
Paddy	32,500	4,500	146,250,000	68.61
Cacao	335	10,753	3,602,255	1.69
Plantain	3,904	4,965	19,383,360	9.09
Coconut	2,500	2,344	5,860,000	2.75
Sut-total (Perennial crops)			28,845,615	13.53
Maize	100	4,007	400,700	0.19
Sweet potato	255	2,618	667,590	0.31
Cassava	255	3,450	879,750	0.41
Haricot bean	16	18,656	298,496	0.14
Vegetables*	189	4,323	817,047	0.38
Sub-total (Annual upland crops)			3,063,583	1.44
Milk**	5,428	3,730	20,246,440	9.50
Beef (Heifer and steer)***	3,161	3,253	10,282,733	4.82
Beef (Cow)***	1,090	4,115	4,485,350	2.10
Sub-total (Livestock products)			35,014,523	16.43
Total			213,173,721	100.00

Note: * Represented by pumpkin, cucumber and sweet pepper
** Output (kl), Price (RD$/kl)
*** Output (head), Price (RD$/head)

Values for paddy, livestock products and perennial crops represented 66%, 16% and 13%, respectively. The value for annual upland crops was around 2%, which coincides with the proportion of the output. The production values attained by crops and livestock produced in the Limon del Yuna area are equivalent to 1.2% and 0.5% of those for the national statistics.

3.7.4 Production Cost and Balance Sheet of Agricultural Production

(1) Production cost

The production cost for paddy cultivation is calculated to be RD$ 15,094/ha, which was obtained referring to the "Plan de Inversion (Investment Plan)" prepared by IAD's project office as well as to the socio-economic survey conducted by the Study team. Breakdown of this production cost is shown in Table F.4.1. This production cost is classified respective category of cost is as follows: Fertilizers and agro-chemicals (28.7%), Manpower (28.5%), Contract

work (aerial fumigation and harvest) (11.8%), Land preparation by machinery and animal (13.5%), seed (8.1%), Interest and commission of agricultural credit (8.3%), and Water charge (1.1%).

Like other developing countries, the Dominican Republic imports the great majority of agricultural inputs such as fertilizers, agro-chemicals and agricultural machinery are imported (the proportion of foreign exchange portion against the total cost for fertilizers/agro-chemicals and agricultural machinery is estimated to be 90% and 70%) and this is the major factor that hiked the production cost (tariffs imposed on import commodities is the highest in the Dominican Republic among Latin American countries). Besides, production cost is raised by higher rate (18%/year) of interest and commission due to agricultural credit, which is considered to be relatively high if modest inflation rate of the country is taken into account. Because of these factors, JAD (The Dominican Agri-business Council) concludes that the production cost for paddy prevailed in the Dominican Republic is almost twice as high as that in Argentine, Colombia and Ecuador.

In the Study area such cultural items as plowing, fumigation and harvest are mechanized, although farmers do not posses machinery (tractor, cultivator, etc.) and equipment, but to employ contractor who undertake these works, meanwhile leveling of paddy fields and transportation of bagged harvests from paddy fields to the nearest road are made by animals. The rest of cultural category depends on manpower (family and/or hired labor).

The unit rate for major cost items of paddy cultivation is as given below.

Items	Unit rate (RD$)	Remarks
Plowing	1,788.00 (ha)	By tractor (Contractor)
Leveling	357.50 (ha)	By animal
Fumigation	143.10 (ha)	By light air craft
Harvest	25.00 (bag)	
Agricultural credit	18%(per annum)	12%(Interest), 6%(Commission)
Water charge	175.22 (ha)	RD$ 11.02/tarea
Hired labor	100 (day)	

It is supposed that only 8% of the manpower input in rice cultivation is represented by family members.

The production cost for crops other than paddy is resumed in the Table F4.2. This table is prepared on the basis of the BAGRICOLA's document entitled as "Programa de Préstamo para el Año 1994 (Credit Program for the Year 1994)"; cost for irrigation and credit are excluded because these crops are rain-fed without credit.

(2) Farming balance sheet

According to BAGRICOLA's cost-benefit analysis on crops, paddy is a promising crop with expected net return around RD$ 7,000/ha. Nevertheless, the

Study team's survey has revealed that farmers in the area attained far lower net return of paddy cultivation attributable to depressed productivity affected by inconsistent supply of irrigation water, poor drainage, inundation, etc.; even at lands with 1st-class capability the attained net return was as few as RD$ 1,500/ha on average - about 20% of the BAGRICOLA's target; balance sheet at lands with 2nd and 3rd-class capability resulted in deficit as a consequence of income-cost analysis.

Balance sheet for crops except for paddy is estimated as indicated in the Table F.4.3 (it should be pointed out that values calculated herewith is subject to major fluctuation, because unit yield and farm-gate price which are the basic factors for calculating crop profitability go ups and downs greatly by season). Tuberous root crops represented by sweet potato and cassava got higher profit owing to lower production cost; plantain and coconut palm also considered to be highly profitable crops, should capital for initial investment be available; in the same manner, the net return got by haricot was satisfactory (RD$ 13,660/ha) owing to its excellent productivity superior (1.3 times) to the national average).

The net return expected by livestock farming is as follows (refer to Table F.4.3 for further information)

Gross Income (RD$/ha/year):	RD$ 13,511
Production Cost (RD$/ha/year):	RD$ 10,898
Net Return (RD$/ha/year):	RD$ 2,613

An extensive farming practice prevailed in the Study area has left livestock farmers with less profit.

3.8 MARKETING AND PROCESSING OF AGRO-PRODUCTS

3.8.1 Marketing System

(1) Rice

Although rice is the most important foodstuff for the diet of Dominican people, its output has not been consistent, because the prevailing cropping system depends largely on climatological conditions. Under the circumstances, the country had to import this basic cereal in eight years for the last 10 years to fulfill domestic demand. For this year of 1995, due to reduced output in 1994 which was caused by unexceptional drought throughout the country, the country imported 30,000 tons of rice in March. With an exception for the year of 1992, an annual output of rice remains low to compare with its level of 10 years ago, thus, in 1993, an apparent consumption per-capital of rice became the lowest level of the last decade with a quantity of 42.8 kg, equivalent to 68% of the same attained in 1986.

In the Dominican Republic, up to 1987 INESPRE (Price Stabilization Agency) had played a vital role within the marketing channel of rice (about 80% of paddy was purchased by this organization), purchasing paddy directly from farmers on the basis of the supporting price established every harvest season of the year. And, due to financial and administrative problems INESPRE's function related with marketing of rice has been turned over to BAGRICOLA since 1987. However, BAGRICOLA does not intervene directly in purchase and processing of paddy as INESPRE had done, but supervise silos turned over by INESPRE, control importation and exportation of rice, and establish through the National Rice Commission reference price of paddy to be traded between farmers and rice mills. At present, purchase of paddy from farmers is made exclusively by private rice mills including cooperatives and middlemen.

The survey to farmers in the Study area has revealed that 57% of the paddy are processed at rice mills within the Study area. Furthermore, according to the same survey, it is estimated, that about 17% of the paddy produced in the Study area is destined for self-consumption of farmers and their family members

Paddy is priced on the basis of the unit called "fanega"; if paddy contains 20% of moisture and 5% of foreign materials, then one "fanega" is determined to be 120 kg. As of January, 1995, one "fanega" of paddy is sold in the range of RD$ 540-560 (equivalent to RD$ 4,500-4,670 per ton) in the Study area. According to the rice mills around the Study area, farm-gate price of paddy fluctuates from RD$ 583/fanega to RD$ 440/fanega during 12 months for the year of 1994.

As mentioned before, although the supporting price for paddy was repealed in 1986, the Government persist to intervene in the market by means of establishment of reference price so that the negotiation of the grain between the buyers (rice mills) and farmers should be made based on this reference price. In such manner, the farm-gate price of paddy in the country is kept in higher level in comparison with that of other countries; the prevailing farm-gate price of RD$ 540/fanega, equivalent to RD$ 4,500/ton in paddy or RD$ 7,500/ton (US$ 582.75/ton) in milled rice is roughly

calculated to be twice as high as the FOB price of the Thai rice (US$ 296/ton, as of December 1994).

So far as the transaction volume is concerned, rice is processed throughout the year, but, generally speaking, peak season falls on October-December and April-May, whereas less volume is processed during January-March.

Judging from hearing made among rice mills' personnel, one "fanega" of paddy produces hulled rice in the range of 155-165 pounds (69.8-74.3 kgs), so the conversion rate of paddy into milled rice is to be 58-62% on the whole. One bag of paddy weigh 92 kgs on average.

Processed rice are determined their price according with the proportion of split grain. This process is made referring to the criteria for classification of milled rice established by the BAGRICOLA. Up to last year, there were five categories of milled rice in terms of quality (Selected A, Selected B, Superior A, Superior B, Superior C), but facing with difficulty and trouble in assessment, the Bank has decided to reduce categories of milled rice in only two (Selected A and Superior) for this year. Milled rice containing split grain less than 8.5% are assessed to be "Selected A" and those less than 28% to be "Superior".

(2) Cacao, plantain

In the national level, cacao constitutes one of four traditional exports that contribute to foreign exchange earning of the country and nearly 90% of its national output is destined to international market. (The participation of this crop in the total export value of the country was about 7% in 1993). Almost the whole of cacao produced in the country are purchased by only six agents who process the crop for exportation as well as for domestic consumption. Cacao produced in the Study area are purchased directly by two of six agents mentioned above with head office in San Francisco Macoris or by middleman at Arenoso.

Like other agricultural exports, an international price of cacao had been depressed since 1980, but, there has shown a sign of recuperation, because after recording the lowest level in the middle of 1993, an international price has began to ascend. In spite of the depression in price, exportation volume of cacao has not decreased drastically as the case of sugar, owing to the governmental policy to promote exportation of the crop with elimination of export tax on it.

Farm-gate price of cacao has been affected by sluggish situation of international price, thus for the last four years (1989-1993) it had grown only by 36%.

Plantain within the Study area is cultivated in its great portion along the Yuna River. Plantain is regarded to be of important foodstuff for the Dominican people, so the great majority of the production is supplied to domestic markets. For the last decade 2,500 tons or so are exported yearly to the USA and neighboring Caribbean countries.

Representative marketing channel of plantain for domestic consumption is as follows:

Farmers=>Middlemen (Forwader)=>Professional Seller=>Wholesaler=>
Retailer=>Consumer

The transaction of plantain is generally done on the basis of the unit called "carga" (200 units) or "millar" (thousand units).

With an expansion of production, rise of the farm-gate price of plantain remains the lowest among the crops produced in the Study area; plantain's farm-gate price has rose for the last 8 years (1986-1993) by only 491%.

(3) Haricot bean, maize

A considerable portion of these products are consumed by farmers themselves or locally; some portions are sold to middlemen who transport them in such markets as Nagua, Cotui, San Francisco Macoris and Santo Domingo.

Although the supporting price for most of crops has been abolished since 1990, haricot bean is one of four crops (others are potato, onion and garlic) to which supporting price is established. The supporting price of haricot bean has hiked by 20 times for the last ten years (1984-1993). Owing to this pricing policy, the farm-gate price of this crop remains the most favorable among the crops produced in the Study area and its index excels the consumer price index for foodstuff by 25%.

The national production of maize is insufficient in the Dominican Republic, therefore domestic supply of this grain for human consumption as well as feeding to animals is satisfied with importation; for the last ten years, on an annual average 343 thousand tons of maize were imported to cover approximately 85% of the domestic supply.

The production of maize in the Study area is in small volume, so almost the whole production is consumed locally (self-sufficiency and poultry farming of farmers and supply for nearby markets).

(4) Tuberous root crops

Tuberous root crops cultivated in the Study area are represented by cassava, sweet potato and yautia. Being traditionally consumed by Dominican people, some portion of these tuberous crops are used for self-sufficiency and reproduction by farmers and the better part of the remainder are destined to local and other domestic market by middlemen; not a little volume of the crops are lost in post-harvest; damaged and inferior products are use for feeding animals.

Cassava, sweet potato and yautia are crops that promise high return to farmers supported by higher level of farm-gate price and low production cost.

(5) Vegetables

Production of vegetables such as pumpkin, cucumber and set pepper is capricious in the Study area without being consolidated firm marketing channel. It is observed that prices for three vegetable crops mentioned here are fluctuated greater than grains and tuberous root crops.

(6) Livestock

According to the survey conducted by Study Team, 0.36 head/ha of cow and 1.64 head/ha of heifer and/or steer are marketed yearly on average in the Study area with prices of RD$ 4,115/head and RD$ 3,253/head, respectively. The same survey also revealed that milk are produced at an average rate of 2,485 liters per hectare per annum with a price of RD$ 3.73/l.

For the decade 1983-1992, about one-fourth of the national supply of milk was covered by imported milk with an average volume of 13,098 ton per year (convertible to 104 thousand kilo liters). An importation of milk has hiked in 1994 attaining 228 thousand kilo liters and covering about 37% of the national supply.

3.8.2 Prevailing Farm-gate Price

Farm-gate prices for the major crops and livestock products produced in the Study area are estimated for the year of 1994 as follows:

Crops/Livestock Products	Price (RD$/ton)
Paddy	4,500
Cacao	4,928
Haricot bean	7,707
Plantain*	873
Coconut*	914
Maize	1,938
Cassava	1,583
Sweet potato	1,122
Pumpkin	1,618
Cucumber	2,786
Sweet Pepper	2,361
Milk**	3,730
Cow***	4,115
Heifer and steer***	3,253

Note: * In thousand units
** per liter
*** per head

3.8.3 Processing and Storage Facilities

A total of 18 rice mills are installed within the Study area. Of these rice mills, one has been operated by the Limon del Yuna Agricultural Federation (FALY) since 1992. Apart from these 18 rice mills, one large-scale mill with drier is found both in Villa Riva and in Arenoso. Furthermore, another 18 rice mills equipped with drier are located within the influential area of the AGLIPO project, although 6 of them are out of operation.

As shown in this table an integrated milling capacity of rice mills in the Study area reaches 13.73 tons per hour (calculated paddy basis), and if included rice mills in Villa Riva and Arenoso, the same capacity is to be elevated to 20.16 tons per hour. Referring to the information registered at INDRHI's regional office, the peak harvest month in the Limon del Yuna area come to November when approximately 5.5 thousand tons of paddy are harvested. For processing 5.5 tons of paddy a month, an integrated capacity of 27.5 tons/hour (5500 ÷ 25 ÷ 8 = 27.5) is required for rice mill. This calculation draws the conclusion that the existing facilities in the Study area can not comply with processing of the whole of the paddy to be harvested within the area at the peak harvest season.

It is worth while adding that a rice processing and storage complex project has just inaugurated in March 1995 at El Pozo area under the technical and financial assistance rendered by the Government of Italy. This project entitled as "Consorcio Cooperativo Arrocero El Pozo de Nagua-El Pozo, Nagua Rice Cooperative Consortium" is implemented to benefit 3,500 farmers affiliated with 21 cooperatives and cultivating a total of 7,550 ha of paddy fields, and to generate direct job opportunity for 500 persons with a total cost of US$ 20 million (US$ 19.4 million are donated and loaned by the Government of Italy) approximately. The purpose of this project is to produce high-quality rice seeds, to purchase and paddy from settlers of IAD's agrarian reform project area at El Pozo for processing them and to store and market processed rice. The project also aim to process sub-products of rice for their better utilization. At the initial stage for operation of the project, transfer of the technology will be made from Italian experts as well as Dominican public agencies consist of BAGRICOLA, SEA, IAD, INDRHI, INESPRE and IDECOOP (Cooperative Development and Credit Institute), but the operation and management of the project shall be entrusted to the El Pozo Cooperative Consortium in all aspects.

Besides rice mills, there are only a few small dairy processing plants to produce cheese in the Study area.

3.8.4 Constraints on Development

Constraints associated with marketing and processing of paddy may be resumed as follows.

- Farm-gate price of paddy in the Dominican Republic is comparatively elevated in comparison with the international market owing to the governmental policy to protect farmers engaging in production of the grain. With a progress of world-wide tide for opening markets to foreign products, domestic rice farmers would be sacrificed greatly if this high pricing policy shall be maintained in the future.

- Although the Government, through BAGRICOLA, has established policies to facilitate construction of rice mills from the part of farmers organization, in particular, at agrarian reform project areas, but getting finance from BAGRICOLA for this purpose is not easy being required complicated procedure and prolonged period.

- Only 4 of 18 rice mills existing in the Study area are equipped with drier; rice mills without drier dry paddy in the sun without attaining higher rate of drying under higher rainfall condition of the area, which causes to produce inferior quality of milled rice.

- The quality of milled rice is classified in accordance with criteria (mainly based on the proportion of spilt grain) established by BAGRICOLA and although, there were five categories in terms of quality classification until 1993, they are reduced to two in 1994, facing with difficulty and complexity in assessment. This situation discourages rice mills to produce better quality milled rice.

- The determination for the content of moisture and foreign materials to be made by purchasing agents of paddy is made not by means of laboratory test but by traditional method called "al ojo (by eye)". There is no form ground how the determination is made.

- Existing rural organization such as federation, cooperative and association are not working effectively for the purpose of better marketing of paddy as is the case of the Cooperative El Pozo.

Production of crops other than paddy is small in volume and inconsistent. Marketing channel for traditional crops such as cacao, plantain and coconut is relatively firmly consolidated and their farm-gate prices are less variable. Transaction for the rest of crops is subject to sharp fluctuation. The marketing system related with crops except paddy presents the following constraints:

- There is no wholesale market in the vicinity of the Study area and farmers do not have vehicles to transport their products, so farmer have only to wait for coming of purchasing agents. This situation brings substantial loss of crops in post-harvest.

- Farmers without being organized have inferior capacity in negotiating prices with purchasing agents.

- In the absence of market information system for transacted volume and prices both national and regional level, farmers are not in a position to decide their cropping plan taking advantage of escalated price.

- Under-development of road network is likely to damage fragile crops such as vegetables and fruits.

3.9 INSTITUTIONAL SUPPORTING SYSTEM AND RURAL ORGANIZATION

3.9.1 Responsible Institutions for the Supporting Services

In the Study area, the following governmental agencies are rendering institutional services aiming to increase and stabilize agricultural production as well as to ameliorate living standard of farmers. These institutional services, nevertheless, have not produced anticipated benefits due to lack of both manpower and equipment/materials attributable to insufficient budgetary allocation.

Ministry of Agriculture (SEA):

SEA is responsible for preparing and executing agricultural development policies and takes charge in conservation and utilization of natural resources. SEA's eight regional offices within the country are established to put these policies into force and promoting agricultural activities. The Study area is under control of San Francisco de Macoris regional office, which covers the northeast region of the country comprising 4 provinces. Services provided in this regional office are divided into two departments: agriculture and livestock. Each province has its zone office supervised by the regional office and a total of 18 sub-zone offices are attached to zone offices. In these offices, approximately one hundred extension workers are working to render technical assistance services to farmers. The Study area is under direct control of Limon del Yuna and Villa Riva sub-zone offices (Refer to Fig. H-1, Annex H).

Dominican Agrarian Institute (IAD):

IAD, a substructural organization of SEA, is an implementing agency of agrarian reform project; IAD distribute national lands free of charge to landless candidates who desire to engage in agricultural production and renders socio-economic and technical supporting services to settlers so that their living standard should be improved. For materializing this function IAD has established 11 regional offices and 6 decentralized project offices. In 1967 IAD established new agrarian reform project office, "PROYECTO DESCENTRALIZADO AC-46 LIMON DEL YUNA", at La Reforma within the Study area (See Fig. H-2, Annex H). The office is under direct control of IAD's headquarters, taking account of the magnitude of distributed area (7,000 ha) and the number of settlers (2,000 families). The office extends the following services to the settlers:

- Promotion for forming organization among settlers;
- Technical assistance on farming;
- Mechanization of cropping culture; and
- Coordination for getting agricultural credit.

National Institute of Hydraulic Resources (INDRHI):

INDRHI is also a substructural organization of SEA and is in charge of planning, design and implementation of water control, irrigation and drainage, performs functions to study, plan and implement water resources development (including groundwater development), hydraulic power generation, irrigation . drainage and flood control project, and administrates and supervise irrigation and water control facilities except for power generation facilities. The institute divides whole the country into nine districts by river basin. The Study area belongs to the Yuna River Lower Basin district office located in Nagua and is directly controlled by Limon del Yuna branch office at Barraquito and Villa Riva branch office, which are undertaken maintaining canals and collecting water charges (See Fig. H-3, Annex H).

Agricultural Bank (BAGRICOLA):

The BAGRICOLA is a national financing agency to render agricultural credit to farmers, in particular those who are without mortgage. Credits of the Bank are rendered to beneficiaries of the agrarian reform projects under coordination of IAD and to private farmers under assessment of the Bank's agricultural engineers. Study area is under jurisdiction of BAGRICOLA's two branch offices at Arenoso and Villa Riva. The Arenoso office was established in 1974 and is in charge of Limon del Yuna area. The Villa Riva office was established in 1980 and is in charge of the left side of the Payabo river (See Fig. H-4, Annex H).

Agricultural Materials Sales Center (CVMA):

CVMA is directly attached to SEA and sells agricultural inputs and machinery. CVMA's office within the Study area has a function to stabilize prices selling agricultural materials such as fertilizer, pesticides, farm tools and small agricultural implement to farmers.

Rice Research Center (CEDIA):

CEDIA, a decentralized organization of SEA having an office and an experimental farm in Bonao, is in charge of research on development and improvement of rice variety and rice production technology and has nine divisions (agronomy, seed genetic, breeding, seed production, soil and fertilizer, pest control, water management, laboratory of seed, and mechanization). The branch office at El Pozo is producing rice seeds. CEDIA has developed high-yielding seeds such as Juma 57 and Juma 58; in particular, the latter is highly suitable to agro-climatological conditions of the Dominican Republic and is sowed in 80% of paddy fields throughout the country and 90% of the same in the Study area.

3.9.2 Features of Institutional Services

(1) Agricultural extension services

Extension services of agricultural technology is currently provided by SEA's sub-regional offices and IAD's project office. SEA's services coverage area is divided by

the Payabo River; Limon del Yuna sub-regional office is in charge of the right margin area and the left margin area is covered by Villa Riva sub-regional office. Meanwhile, IAD's services, which are provided exclusively to settlers, are under the solo responsibility of the Limon del Yuna project office, although its branch office located at La Ceiba de los Pajaros covers partly the left margin area of the Payabo River.

Services rendered by these office include:

- Advise in selection of proper crops;
- Transfer of technology on cropping technology;
- Application method of fertilizer and agricultural chemicals;
- Demonstration of cultivating method at farms;
- Advice on improvement of living environment;
- Coordination for getting agricultural credit;
- Distribution of seed and seedling except rice (SEA); and
- Assistance in improvement of communication network.

Major constraint related with extension services is lack of transportation which limits the frequency of visiting farmers to render services. In addition, deficient office equipment prevents officers to engage adequately in collection and administration of data and information. Another aspect of problem concerning with extension services is that, even if the coverage area of these two institutions coincides, there is no substantial coordination between them in relation with exchange of opinions on method and information of the services so that an efficient services may be realized.

(2) Operation and maintenance system of irrigation and drainage facilities

1) Operation and maintenance organization and method

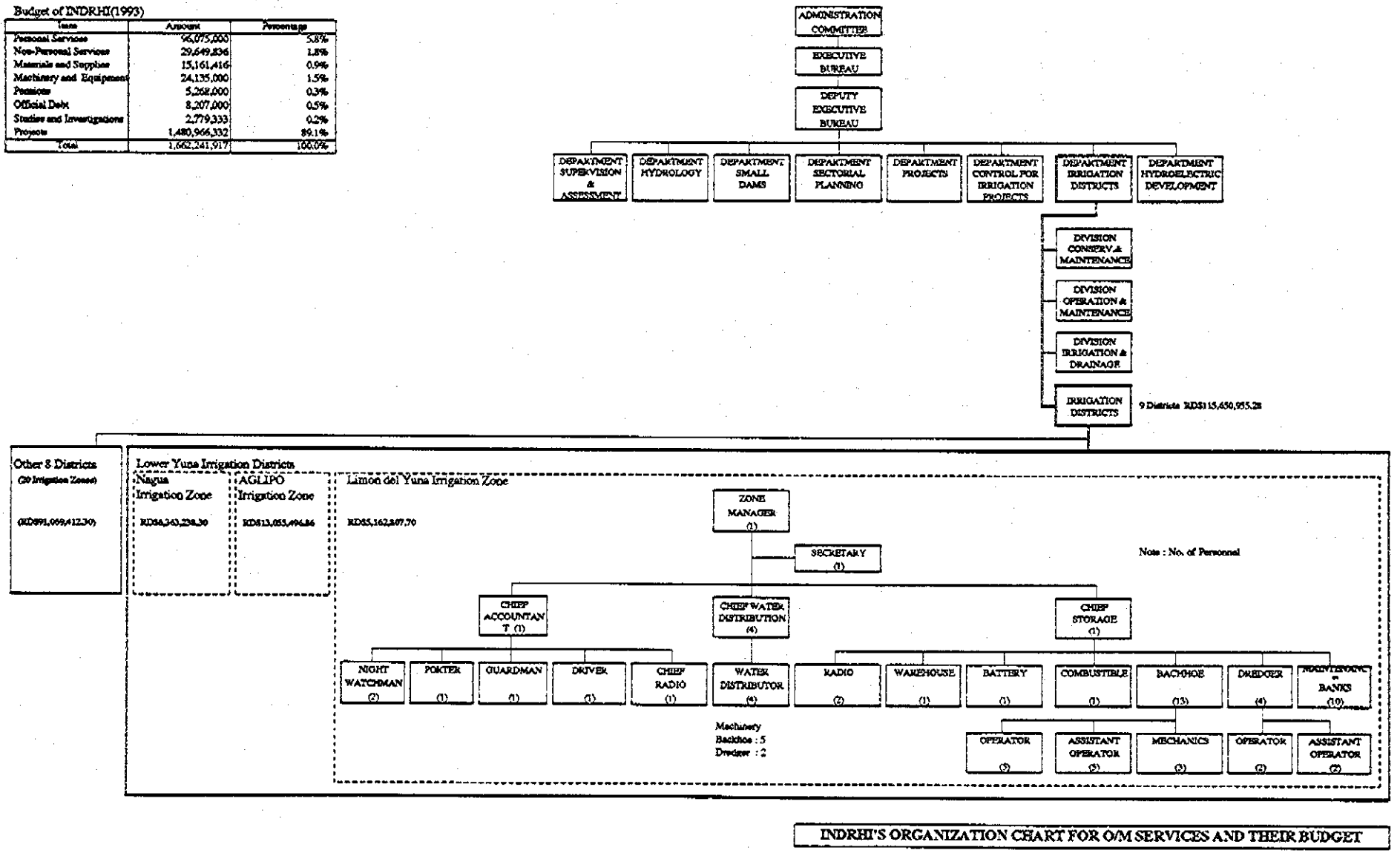
The operation and maintenance of irrigation system is under responsibility of INDRHI's Department of Irrigation Districts, which controls and administrates nine (9) irrigation districts throughout the country; these irrigation districts, in turn, supervise irrigation zone totaling up to 23 to cover the whole country.

Intake works, main and lateral canals, diversion works, gates and other works related with irrigation and drainage system within the Study area is administrated and operated by INDRHI's Lower Yuna District Office and Limon del Yuna zone office as illustrated in the following page. It is thus judged that the horizontal structure for O/M services is duly established within INDRHI's organization.

Nevertheless, services realized by the Limon del Yuna zone office is concentrated on excavation works of irrigation and drainage canals, so installation and improvement of structures to provide more appropriate services is not contemplated. Neither equipment nor personnel to take charge of tertiary system is not assigned at the office; O/M services at the tertiary system can not be provided adequately without participation of farmers, so the outcome of the services depends heavily on the degree of participation of farmers.

Budget of INDRHI(1993)

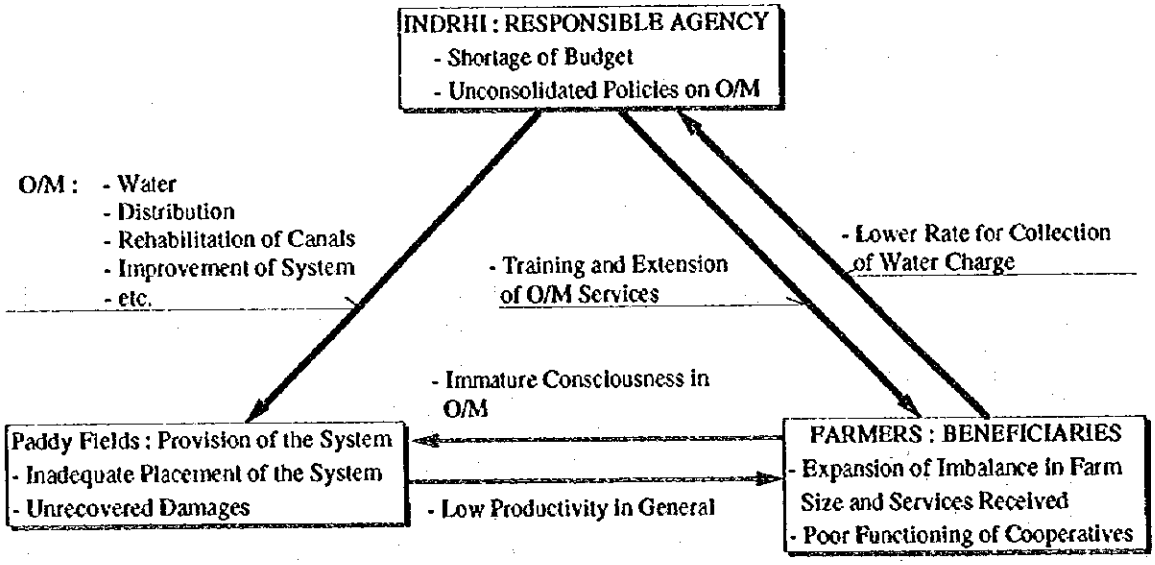
Item	Amount	Percentage
Personal Services	96,075,000	5.8%
Non-Personal Services	29,649,836	1.8%
Materials and Supplies	15,161,416	0.9%
Machinery and Equipment	24,135,000	1.5%
Pensions	5,268,000	0.3%
Official Debt	8,207,000	0.5%
Studies and Investigations	2,779,333	0.2%
Projects	1,480,966,332	89.1%
Total	1,662,241,917	100.0%



INDRHI'S ORGANIZATION CHART FOR O/M SERVICES AND THEIR BUDGET

Nearly 89% of the INDRHI's budget is allocated to implementation of projects in 1993 and 9% of the same is covered by district offices, so it is considered that the emphasis of INDRHI's budget allocation is laid on implementation and O/M of irrigation projects. The Lower Yuna District Office absorbs 21% of the sum of budget allocated to the district offices, which is explained by the fact the AGLIPO zone office has a budgetary allocation 2.6 times more than the average of other districts. This higher allocation of budget to the AGLIPO office is associated with INDRHI's position to deal with sincerely O/M services for non-traditional large-scale pumping station and tidal gate as well as for canals placed at lower land with dull flow of water caused by thick growth of weeds. Nevertheless, even this AGLIPO office the budget allocation in terms of absolute value is not enough, therefore O/M services are actually rendered capriciously as rehabilitation works require. So far as the Limon del Yuna zone office is concerned, the O/M services are unsatisfactory with limited budgetary allocation which hinders to repair deteriorated machinery and equipment.

The actual situation of the O/M services may be illustrated as shown below resuming in the form of relation among INDRHI (responsible entity), farmers (beneficiary) and farms equipped with irrigation and drainage works. As the figure below indicates, each sector contains constraints within itself and inter-related components of the same lead to worsen O/M services. Besides shortage in financial resources, major factors related with poor functioning of O/M services are: farmers' attitude to depend O/M services on governmental agencies, inadequate provision of irrigation and drainage works at farm level, etc.



With improvement of irrigation and drainage works, O/M services at farm level may be ameliorated, but for this end the participation of farmers in providing O/M services shall be essential owing to the fact that:

- An exquisite services would not be put into force without participation of farmers who are closely associated with problems of the services;
- The prevailing horizontal structure of INDRHI (responsible entity) and farmers (beneficiary) can not facilitate forming farmers' organization; and
- It is not viable to raise budget for O/M services drastically.

2) Water charge

Because the Government had subsidized greatly the O/M of irrigation system, the proportion of the total amount of water charge collected form water users against the total expense incurred for the O/M services had been below 20% up to 1989. From 1990 on, however, within the context of the structural reform policies, new pricing system of water charge called "factor de cobre (collection factor)" was introduced, and with putting this new system into force, the said proportion has been raised remarkably. In spite of this improvement, the proportion still remains around 70%, and this situation is explained by the fact that (1) there are not a few water users who do not perform their duty to pay water charge and (2) some portion of O/M expenses are still covered by the Government.

Water charge imposed on farmers who owe BAGRICOLA is deducted from their loan amount in advance. Water charge is calculated for respective irrigation project and is different within the same project by farm size (larger or smaller than 10 ha) and crops (paddy or other crops) to be irrigated.

In the Dominican Republic, farmers of the AGLIPO Project are imposed the highest water charge and are followed by those of the CONSTANZA Project. So far as the Study area is concerned water charge is collected from farmers according with the following rate:

Gravity irrigation:	RD$22.06/tarea = RD$350.75/ha (Smaller than 10 ha; paddy for double crops)
Pumping irrigation: from canal	RD$13.24/tarea = RD$210.52 (60% of gravity irrigation)
Pumping irrigation: from the Yuna river	RD$5.52/tarea = RD$87.77/ha (25% of gravity irrigation)

Referring to INDRHI's record of water charge which covers 70% of the total irrigated area of the Limon del Yuna Project, the amount of water charge collected and accumulated debt up to the year of 1993 are revealed in the following manner.

Collected water charge:	RD$2,406,810.35
Accumulated debt:	RD$5,411,429.50

Close to double amount of the water charge to be paid is overdue.

Major reasons for being overdue are:

- Lack of financial resource to pay water charge
- Refusal to pay because water is not distributed in time of necessity

3) Establishment of water users' association

Like other countries, the privatization policy which pretends to transfer functions and responsibilities of public sector to private sector is in progress in the Dominican Republic, and in line with this policy, some portion of INDRHI's responsibilities and undertakings relevant to operation and maintenance of irrigation system is being turned over to water users' association (Junta de Regantes). Legislative background of this turn-over is the "Water Law", which is examined by legal consulting committee to be placed to the Congress for ratification. The importance of this turnover policy was confirmed by the resolution promulgated by the National Agricultural Council-the top ranking organization to determine government's agricultural policy; in the article 1 of the said resolution, the Resolution No. 4/95, it was declared as "the highest priority of the INDRHI's irrigation policy shall be laid on conforming "Junta de Regantes" and decentralizing gradually the operation of irrigation system to them, which will contribute to better utilization of water resources and to raising agricultural productivity of the country".

In advance to the legislation at the Congress, the trend to turn over INDRHI's irrigation system is accelerated and autonomous operation and maintenance of irrigation system by "Junta de Regantes" has been realized at 7 irrigation projects all over the country. The irrigated area covered by "Junta de Regantes" reach 55,000 ha in total, which represents 24% of the total irrigated area of the country.

"Junta de Regantes" has not been established at the Study area, but is now in operation at the AGLIPO I (El Pozo) project area. The formation of "Junta de Regantes" at AGLIPO project is realized by initiative of completion for both the AGLIPO Agricultural Development Project and El Pozo Rice Consortium Project, which planted farmers the importance of O/M services. By contrast, at the Limon del Yuna project area irrigation and drainage works are under-developed and no adequate water management system is established. In this context, it is not anticipated that O/M services would be enhanced after turnover of the irrigation system from INDRHI to users, if the prevailing system will remain unchanged.

4) Operation and maintenance of irrigation system by "Junta de Regantes"

The turn over of irrigation system from INDRHI to "Junta de Regantes" is not made drastically but gradually; up to date the turn-over of O/M services is limited to secondary and minor irrigation canals and drainage canals used to

evacuate agricultural waste water, so INDRHI's responsibilities still fall on the main irrigation canal and the drainage canal to discharge flooded water.

The water users' association is generally composed of the following two levels:

- Junta de Regantes: This level is established to each irrigation project and shall be responsible at the end for construction, improvement, operation and maintenance of common irrigation works from intake to determined point in which irrigation water may dispose to water users. This level shall also take charge of incorporating and collection water charge.

- Water Users' Association: This level shall be an operation unit in such aspects as distribution and delivery of irrigation water to farmers, and operation and maintenance of minor canals. This level shall integrate "Junta de Regantes".

In irrigation project areas where "Junta de Regantes" exists, water charges are collected not by INDRHI but by the "Junta de Regantes". Water charges are calculated based on the annual budget for O/M services of irrigation system. It is reported that the proportion for recovery of O/M cost was improved at the irrigation areas managed by "Junta de Regantes" in comparison their previous situation when they are managed by INDRHI.

With turnover of irrigation system from INDRHI to "Junta de Regantes", positive effects are observed, but the O/M of irrigation system by the "Junta de Regantes" still has the following limitations:

- "Junta de Regantes" does not have access to get loan from public financial institutions to purchase necessary O/M machinery and equipment as well as to employ technical administrative staff.

- The proportion for recovery of O/M cost still remains low, which prevents from conducting proper O/M services.

- Water charges are included as a component of agricultural credit to farmers and are deducted by BAGRICOLA at the time of disbursement of the credit. This deducted amount should be paid immediately from the BAGRICOLA to "Junta de Regantes", but in reality is not the case and it provokes financial crisis of "Junta de Regantes".

- The manual for O/M of irrigation system is not prepared, so there is no innovated O/M services conducted by "Junta de Regantes" to improve them drastically.

(3) Agricultural credit

In realizing rice production, farmers in the Study area depend on finance provided by BAGRICOLA, commercial banks, agricultural federations, rice mills, etc.

Beneficiaries of the agrarian reform project who do not possess mortgage for the loan have no access to agricultural credit except for that of BAGRICOLA. In getting loan form BAGRICOLA, farmers without mortgage are requested to be a member of any organization subject to IAD's coordination to the matter. On the other hand, private farmers need to be investigated by bank's officer under the guideline of BAGRICOLA or commercial banks their financial capability to repay loan.

The amount financed by BAGRICOLA at Arenoso and Villa Riva in 1993 and their shares for the Study area are as follows:

Arenoso: RD$51.6 million
(95% for the settlers in Limon del Yuna area)
Villa Riva: RD$17.0 million
(80% for the farmers at Ceiba de Los Pajaros area)

The interest rate, commission and other levies accrued to the BAGRICOLA's agricultural credit is set to be 18% (12% for interest, 2% each for legal procedure, technical assistance, and commission) per annum as of 1994. The repayment of credit for annual crops is requested to be made within six month. Loaded interest is imposed on dilatoriness of repayment in such manner as: 0.5% for shorter than 2 months, 1.0% for 2-4 months, and 2.0% for longer than 4 months. The approval for credit is made as follows:

- Branch office: Fewer than RD$ 400,000; period: about three weeks
- Regional office: RD$ 400,000 - 600,000; period: about one month
- Head office: More than RD$ 600,000; period: about three months

The debtors of BAGRICOLA are not necessarily satisfied with the bank's credit services and their complains may be summarized as follows:

- They are burdened with higher rate of interest and other levies,
- The interval between application and disbursement of credit is too prolonged,
- The standard for approval of credit is relatively strict,
- The repayment term for credit is too short.

3.9.3 Rural organization

In the Study area, there are three types of rural organization formed by farmers: association, cooperative and federation. From 1973 on, settlers of IAD's project are obliged to affiliate themselves with any of these organizations. Features of three organizations are as mentioned below:

Association:

This organization, which came out by the Decree No. 520 (July 26, 1920), is a fundamental organization formed by fewer affiliated members ranging from 10 to 20. A total of 121 associations with 2,000 families have formed up to date in the AC-46 (Limon del Yuna) project area.

Cooperative

This organization, which is contemplated by the Decree No. 127 (January 27, 1964) and is composed of associations, aims to practice cooperativism. In the AC-46 project area, 5 cooperatives have been organized, although they are not working actively. These five cooperatives are:

	No. of Associations Affiliated	No. of Families Participated	Year of Establishment
Barraquito	17	145	Nov. 12, 1993
La Reforma	9	96	Nov. 9, 1994
Los Peinados	7	104	No. 9, 1994
Paraguay	9	99	Dec. 21, 1994
La Pista	10	80	Dec. 21, 1994
Total	52	524	

Federation:

A federation named as "Limon del Yuna Agricultural Federation (FALY)", which was voluntarily established at Guaraguao in 1983 following the said Decree No. 520, is composed of 42 associations with 500 members. Major activities are as follows:

- Agricultural finance;
- Technical assistance;
- Mechanization of agriculture;
- Sale of agricultural materials such as fertilizer, agricultural chemicals, rice seed, etc.;
- Purchase of unhulled rice and their drying and milling;
- Sale of hulled rice; and
- Social services.

Apart from the above-mentioned federation, another federation named as "Rosa del Duran" is being prepared for incorporation with 25 associations composed of 128 members.

3.10 IRRIGATION AND DRAINAGE SYSTEM

3.10.1 General Description

The irrigation system in the Study area is more adequately provided than that of Aguacate-Guayabo area, and that of El Pozo area before completion of development works; trunk road network is almost consolidated and there are a total of 6,680 ha of paddy fields which are benefited by irrigation works either gravity system or pumping system.

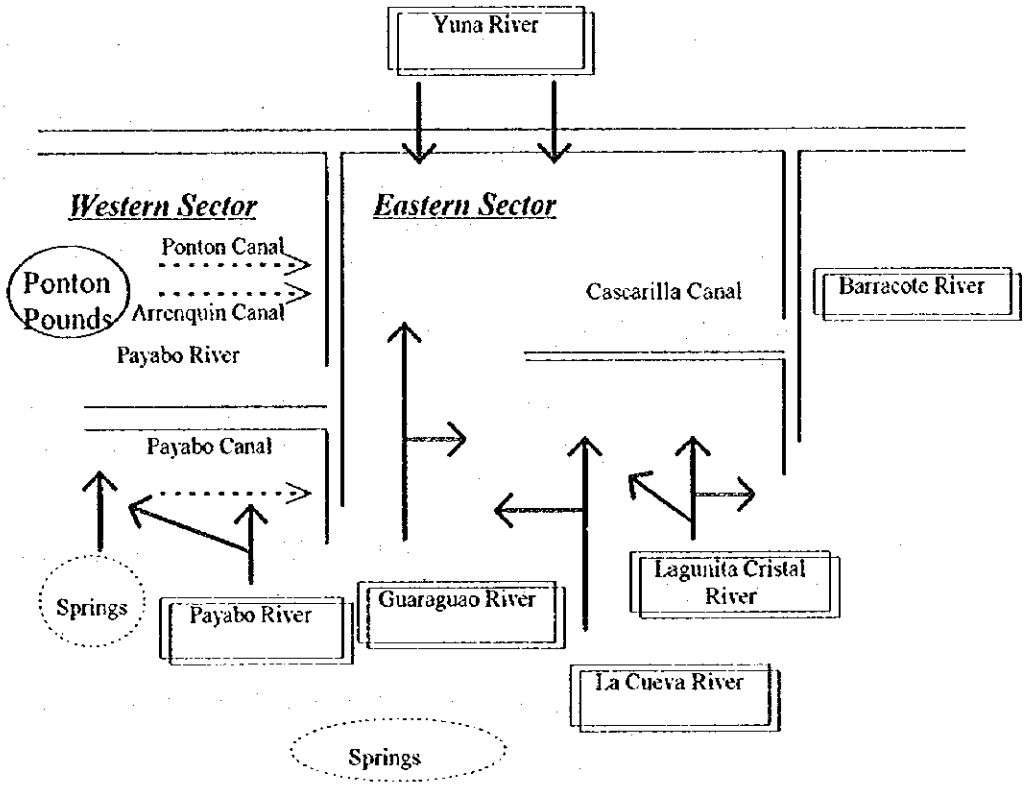
Irrigation and drainage network in the Study area is divided into two major sectors (western and eastern) by the Payabo river and its tributary, the Guaraguao river; the western sector has a total irrigated area of 2,540 ha benefited by the Payabo river and the major portion of paddy fields situated there are not properly prepared, meanwhile paddy fields of the eastern sector, which account for 4,140 ha in total, have attained considerable grade of consolidation benefited by irrigation water supplied from springs; within the eastern sector there are some privately owned paddy fields which are irrigated taking water from Yuna river by means of pumping system and these paddy fields are not adequately consolidated. In so far as drainage system is concerned, most of excess water is discharged into the Payabo river in the western sector and into the Cascarilla canal in the eastern sector.

3.10.2 Sources of Irrigation Water and Intake Facilities

(1) Sources of irrigation water

Sources of irrigation water in the Study area are classified into three systems:

- Payabo river (Western sector);
- Springs water (Eastern sector);
- Yuna river (Eastern sector)



Sources of Irrigation Water	Payabo River		Springs			Yuna River	
Irrigation Block	Ponton	Payabo	Guaraguao	La Cueva	Lagunita Cristal	Borojol	Total
Irrigated area (ha)	1,910	630	2,280	330	770	760	6,680
Pumping Irrigation (ha)	980	240	460	30	0	760	2,470

1) Irrigated area by Payabo river: 2,540 ha

Payabo river is separated into two streams just before this flow enters from mountain to plain land; the right stream discharges into the main irrigation canal to irrigate 630 ha of paddy fields located southern part and its remaining flow drops into the Payabo river. The left stream, which joints with spring water, flows into Caño Ponton and discharge from this source is separated into two canals (Ponton and Arrenquin) for irrigating 1,910 ha of paddy fields located on the left margin of the Payabo river.

2) Irrigated area by Springs: 3,380 ha

There are five major springs at the eastern part of the Study area which store water originated from Los Haitises. Three of these springs constitute consistent source of irrigation water, while the remaining two have not enough water level to supply their water to paddy fields by gravity. The Guaraguao spring has the most abundant discharge which benefits a total of 2,280 ha and discharges of Lagunita Cristal and La Cueva irrigate 770 ha and 330 ha, respectively.

3) Irrigated area by Yuna river: 760 ha

About 760 ha of paddy fields near the Borojol village located between Yuna river and Cascarilla canal are irrigated pumping water from the Yuna river directly.

Within the Study area, close to 40% of paddy fields rely irrigation water on pumping system, and this situation is explained as follows:

- Water level of irrigation source is lower than elevation of paddy field: 1,070 ha

  Apart from irrigated area by the Yuna river, some paddy fields (310 ha) on the outskirts of Caño Ponton have land elevation higher than water level of the spring and thus are dependent on pumping system. Some of these fields take directly from Caño Ponton and others through the canal.

- Pumping system was contemplated at the planning stage of irrigation system: 600 ha

  Paddy fields (340 ha) located lower part of the Payabo irrigation block are always distributed water pumping from Caño Azul. In the Guaraguao irrigation block, on the other hand, irrigation canal is placed at lower elevation land, so pumping system is indispensable to supply paddy fields (360 ha) of higher land elevation with water.

- Pumping system was introduced to compensate shortage of water: 800 ha

  Paddy fields within the Study area have been developed beyond irrigable area by existing water resources and an absence of structures that enable rational distribution of irrigation water have caused shortage of irrigation water at paddy fields located lower

part of canal network. In addition, some farmers use pumps to avoid dispute with other farmers in getting water. These factors together have accelerated installation of potable pumps within the Study area. Paddy fields under these situations reach 800 ha in total.

(2) Water intake system

Water intake system in the Study area are classified into the following four types.

a. Intake from the Payabo river

Irrigation water from the Payabo river is taken by gravity without any weir. Whole amount of river flow discharges to irrigation canal and some discharge beyond flowing capacity of canal return to the Payabo river through spillway.

b. Intake from Caño Ponton

Water discharged from Caño Ponton is separated into Ponton canal and Arrenquin canal. A water gate, which was installed before, was removed because of its physical deterioration and this spot is protected by wooden fence; this fence is not serving for diversion of water but only for spilling excess water. Because there is one-meter-difference between water levels of Caño Ponton and Arrenquin canal regulating water discharge may be possible if water gate and spillway are installed; actually without installation of these structures, the discharge from Caño Ponton to Arrenquin canal decreases in proportion to reduction of water resources at Caño Ponton.

c. Intake from springs

Irrigation water taken from three springs is diverted into two to four canals under control of water gate, although some improvement works for gate is necessary for attaining effective functioning of diversion.

d. Pumping from the Yuna river

The topography along the Yuna river has the highest elevation at river levee and becomes lower from river to Cascarilla canal with similar slope. Thus, water pumped from the river flows by gravity, thus farmers have installed pumps there. The Yuna river functions as irrigation canal in this zone; with casing pipes placed on river levee water is pumped a maximum of 7-8 meters to discharge into canals constructed near the levee.

3.10.3 Irrigation Canals and Related Facilities

(1) Irrigation canals

Irrigation canals are constructed to cover the great majority of the Study area and paddy fields within the area are supplied water through this canal network. All of these canals are unlined canals and serve for both irrigation and drainage purposes except for the main canals. Lateral canals are not worked adequately due to thick growth of weeds and sand sedimentation. Paddy fields located at higher land elevation or near the end of canals take water from canals with aid of pumps. Features of major canals are as described hereinafter.

Ponton Canal

The Ponton canal (approximately 9.8 km in length-the main canal) runs toward the northeast along the Yuna river in the western part of the Study area and water to this canal comes from the Payabo river and springs. This canal benefits a total of 1,420 ha of paddy fields. The original route of the canal was modified partially in 1980. Pumping irrigation is practiced at both paddy fields around the starting point of the canal with higher land elevation and those near the end of the canal.

Arrenquin Canal

The Arrenquin canal (approximately 9.3 km in length-the main canal), placed to the south of the Ponton canal, irrigates 490 ha of lands. Sources of water for this canal are the same as the Ponton canal and some portion of the discharge through the Ponton canal deviates to the Arrenquin canal. The original route of this canal was also modified from 1976. Paddy fields around the end of the canal rely irrigation water on pumps because necessary water is not distributed up to canal end. The major structure of this canal system is an aqueduct crossing over the Payabo river with flowing capacity of about 0.3 m^3/s.

Payabo Canal

This canal (approximately 5.0 km in length-the main canal) passes through southern part of the Study area for irrigating 630 ha of lands. Although this canal was designed to joint with the Guaraguao canal at the planning stage, the construction works have been suspended after completion of half of the designed length. Major source of water is the Payabo river. Without having sufficient cross section, overflow of water is frequently taken place.

Guaraguao Canal

Water flowing this canal (approximately 4.8 km in length-the main canal) is taken from the Guaraguao river and benefited lands by this canal reach 2,280 ha in total. Intake weir and diversion works installed at 3.2 km from the source of water are main structures of this canal system and from these structures two secondary canals are extended to the east and to the west. Structures are not working properly affected by physical deterioration, so rehabilitation works are required.

La Cueva Canal

Taking water from La Cueva spring this canal (approximately 2.5 km in length-the main canal) irrigates 330 ha of paddy fields through three lateral canals.

Lagunita Cristal Canal

This canal (approximately 3 km in length-the main canal) depends irrigation water on Lagunita Cristal. Irrigation water is supplied to 770 ha of lands through three canals.

(2) Related structures

Major related structures of irrigation canal in the Study area are intake weir and diversion works. These facilities are concrete structure, but their physical deterioration together with inadequate O/M services has prevented rational distribution of water through canals.

(3) Constraints of irrigation system

The major constraints of irrigation system in the Study area are as follows;

a. Imbalance of water supply within the area

Generally speaking, lands in the Study area slope down from west to east. Such irrigation blocks as Payabo, Ponton and Guaraguao located to the west of the area with higher land elevation have irrigated paddy fields beyond potentials of water resource and are suffered from frequent shortage of water. Irrigation blocks of the eastern sector consists of La Cueva and Lagunita Cristal are supplied irrigation water satisfactorily.

b. Absence of necessary structures

It is observed that intake and diversion works are extremely insufficient and most of existing works are not functioning well. Under the circumstances, due to intake of major portion of discharge at upper stream of canal, paddy fields along the lower stream of canal are obliged to use pump in the face of insufficient distribution of water. On the other hand, spillway and stanching gate are not installed at Caño Ponton and Arrenquin canal, water is discharged without any control resulting in shortage of irrigation water within the area.

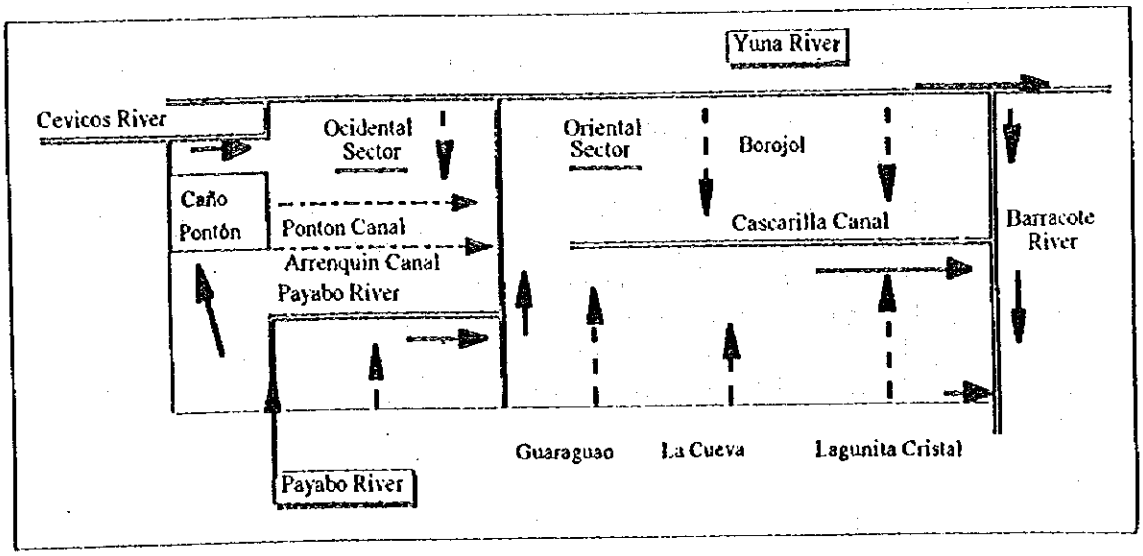
c. Inadequate provision of O/M services

O/M services for irrigation system are not adequately provided due to lower proportion for collection of water charge, insufficient allocation of INDRHI's budget and an absence of water users' association. In addition, major attention of O/M services is paid to excavation of canal by machinery expanding canal section larger than the optimum one. As a result of this unnecessary expansion of canal section, water level tends to lower to such level as make it unfeasible to distribute water by gravity and excavated soils form small embankment.

3.10.4 Drainage

(1) Drainage system

Drainage system in the Study area are divided into two sectors; eastern and western. Major portion of excess water are drained into the Payabo river in the western sector and into the Cascarilla canal in the eastern sector, meanwhile some of them are discharged into the Cevicos river in the western sector and into the Barracote river in the eastern sector.



Payabo River

The Payabo river flows from southwest to northeast within the Study area and joints with the Yuna river. The Payabo river has more than 300 km^2 of the catchment area, 1/3,000 of average river bed slope, 4-5 m width of river section, and 10 m^3/s of flowing capacity. This river is subjected to overflow at high water level stage inundating lands around the river 2-3 days.

Cascarilla Drainage Canal

The Cascarilla canal runs from west to east along the Yuna river and is connected with the Barracote river. The canal has an average slope of 1/2,000 and catchment area of about 60 km^2. This canal has been excavated various times after construction and has enough canal section to permit passage of large amount of discharge. Some lands around lower reach of the canal are often inundated.

(2) Related facilities

There is no structure installed at drainage canal except for simple drainage gates at Caño Ponton and Arrenquin canal, from which flush of water is observed at any time.

(3) Constraints of drainage system

There are two major constraints on the drainage system in the Study area. The first is the inundation and the second is the poor land drainage. Detailed analysis of these constraints is presented in the next section 3.11- "Flooding damage".

1). Inundation

Inundation within the Study area is generally observed at upper reach zone and on the left margin plains of the Payabo river, at lower lands in the southern part of the area, and at the lower stream of the Cascarilla drainage canal. left margin zone of the happens in the Study area on the upstream of Payabo river, on the left flat bank of Payabo river and downstream of Cascarilla canal. Among these areas, the most predominant inundation takes place at the upper reach of the Payabo river caused by small river section associated with backwater coming from the Yuna river.

2). Poor land drainage

Lower lands at the foot of the mountain suffer from poor land drainage, which limits the use of these land exclusively to grazing land.

3.11 FLOODING DAMAGE

3.11.1 Actual Situation of Flooding Damage

As mentioned before major drainage canals within the Study area are the Payabo river and the Cascarilla canal; the former, in particular, causes frequent flooding over paddy fields of its catchment area because of its inferior cross section. The Yuna river, which flows through the northern part of the Study area, has not brought flooding damages over the Study area since 1979 when overflow of river water was taken place due to attack of the cyclone "David"

(1) Payabo river

The Payabo river constitutes an important source of irrigation water in the area and serves as the main drainage canal at the western sector of the area. This river runs from southwest to northeast of the Study area and flows into the Yuna river. The Payabo river has a catchment area of about 340 km^2 at the entrance to the Study area. However, due to smaller cross section (4-5 m) and inflow of backwater from the Yuna river caused by lower river bed elevation (around 2 masl), overflow of river water is sometimes taken place producing flooding damages over surrounding lands.

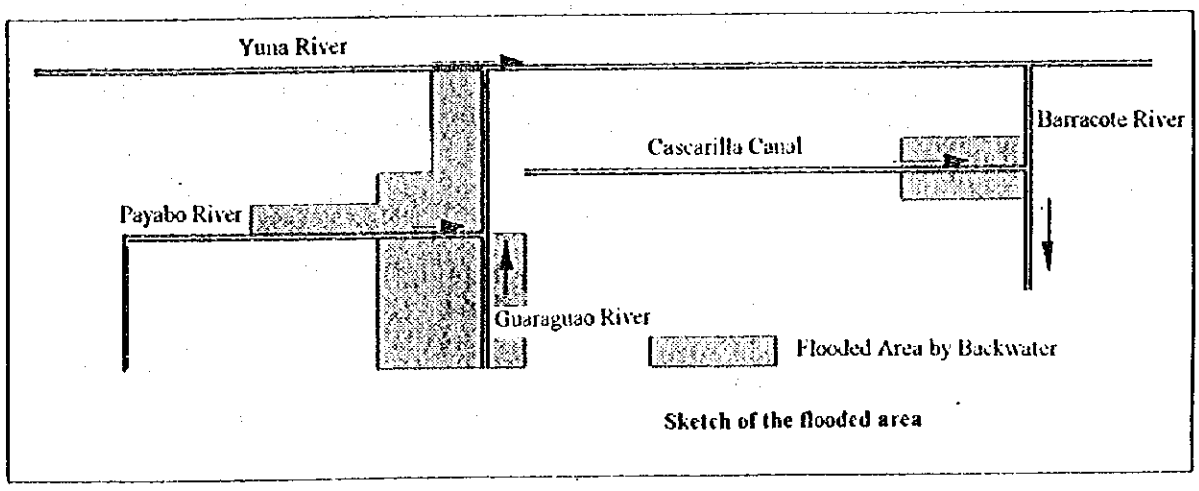
Especially, the narrow topography with 10 km long and 800 m wide formed by land covering the foot of the southern mountain area is transformed into river at the time of flooding stage. The run-off discharge is estimated at 300 m^3/s (five-year-return period) and at 360 m^3/s (ten-year-return period). According to the interview survey on farmers conducted in the course of the field works, inundation remains 2 or 3 days with the maximum submergence depth of 1.5 m. Under the circumstances, land use in this section is limited.

Another inundated zones caused by flooding are: 1) the lower lands on the left margin of the Payabo river and 2) the lands surrounded by the Payabo and Guaraguao rivers as well as by the mountain area. Inundation at these lands is caused by overflow of the Payabo river. Al the lower reach of the Payabo river from the confluence with the Guaraguao river, lands on the right margin of the river are not inundated by overflow of the river thanks to higher embankment of river levee.

(2) Cascarilla canal

Different from the western sector, the eastern sector is not affected by remarkable flooding because no extensive catchment area is located at back area. Owing to repeated excavation of canal section, the Cascarilla canal has enough capacity to permit passage of large amount of discharge. It is informed that flooding damage takes place only at lands around the end of the Cascarilla canal.

The Cascarilla canal runs toward east along the Yuna river and joints with the Barracote river finally with an average slope of 1/2,000 and catchment area of 60 km^2 approximately.



Sketch of the flooded area

3.11.2 Flooding Analysis

Flooding in the Study area is stemmed from: 1) backwater produced by high water level of the Yuna and Barracote rivers, 2) Overflow from the Payabo river, and 3) rainfall within the area. High water level of the Yuna and Barracote rivers does not occur simultaneously, so flooding analysis under influence of these two river should be made independently. Detailed flooding analysis is explained in the following manner.

(1) Influence of the Yuna river

1) Water level of the Payabo river

The watershed of the Payabo river is inundated due to inflow of backwater coming from the Yuna river. Water level of the Yuna river at the confluence with the Payabo river was estimated in the following

manner.

Return Period	1/2	1/5	1/10	1/20
Flood discharge (M^3/s)	530	650	715	750
Section	Water Level of the Yuna River			
Diversion point to Barracote	4.21	4.73	5.03	5.15
El Limon	7.85	8.54	9.00	9.24
Confluence with Payabo	10.53	11.28	11.65	11.84
Villa Riva	13.45	14.19	14.66	14.74
Junco Verde	13.86	14.59	14.95	15.13
El Atro	16.70	17.41	17.78	17.97

2) Influenced area of the flood discharge of the Yuna river

Influenced area of high water level of Yuna river is obtained provided that ordinary flow is discharged from the Payabo river.

Return period	Water Level of Yuna (m)	Influenced Distance from the Confluence (km)
1/2	10.53	15.0
1/5	11.28	17.0
1/10	11.65	17.5
1/20	11.84	18.0

3) Inundated area

Inundated area with submergence deeper than 30 cm and the inundated period for more than 24 hours is as follows.

Return Period	Elevation of Submergence level (masl)	Maximum Submergence Depth (m)	Inundated Area (ha)	
			Total	Paddy Field
1/2	10.53	1.53	1,260	577
1/5	11.27	2.28	1,680	778
1/10	11.65	2.65	2,660	1,738
1/20	11.84	2.83	2,820	1,885

(2) Influence of the Barracote river

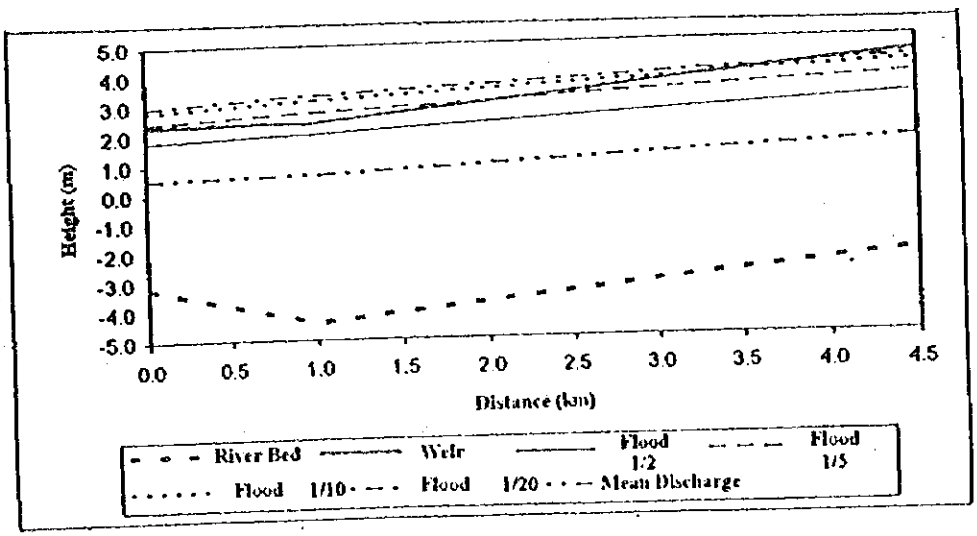
1) Primary water level of the Cascarilla canal

Inundation of paddy fields in the vicinity of the Cascarilla canal basin arises from backwater caused by flood water level of the Barracote river. Diversion discharge from the Yuna river to the Barracote river was assumed making reference to their flowing capacity of these two rivers, and on the basis of this diversion discharge the primary water level of the Cascarilla canal was predicted as given below.

	Flooding Stage				Normal Stage
Return Period	1/2	1/5	1/10	1/20	1/2
Flood discharge of the Yuna (m^3/s)	530	650	715	750	100
Water lever of the Yuna (masl)	4.21	4.73	5.03	5.15	2.52
Diversion discharge to Barracote (m^3/s)	379	483	550	577	18
Rate of diversion discharge against total discharge (%)	71.55	74.36	76.92	76.98	17.81
Section of the Barracote	Water Level (m)				
Confluence with Rio Cristales	1.80	2.44	2.82	2.96	
Confluence with Cascarilla	2.03	2.75	3.16	3.32	
200 Downstream from weir	3.07	3.74	4.14	4.29	

2) Slope of surface water of the Cascarilla canal

Subject to the above flood water level of the Barracote and with assumption that normal flow is discharged into the Cascarilla canal, the following slope of surface water will be made.



3) Inundated area

Inundated area with submergence deeper than 30 cm and the inundation period for more than 24 hours is as follows.

Return Period	Elevation of Submergence level (masl)	Maximum Submergence Depth (m)	Inundated Area (ha)	
			In Total	Paddy Field
1/2	2.03	0.03	290	49
1/5	2.75	0.75	550	187
1/10	3.16	1.16	900	523
1/20	3.32	1.32	990	618

(3) Influence of flood discharge on the Payabo river basin

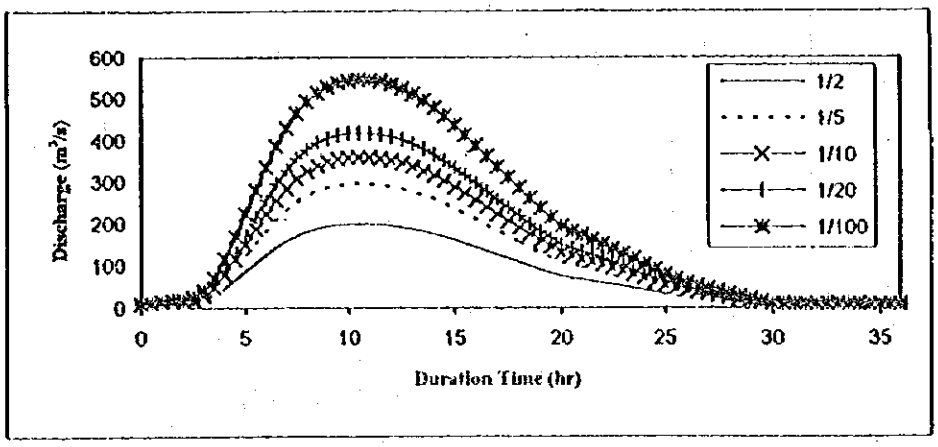
1) Flowing capacity of the Payabo river

Inundation within the basin of the Payabo river occurs, apart from influence of backwater of the Yuna river, due to the fact that flowing capacity of the Payabo river is limited in the face of the flood discharge. The flowing capacity under the present river section is estimated below.

Distance from Confluence (km)	Flowing Capacity (m^3/s)
0.0 - 4.5	80
4.5 - 7.5	60
7.5 - 18.5	40
18.5 - 21.5	10
21.5 - 24.0	5

2) Flood discharge of the Payabo river basin

The flood discharge of the Payabo river at the entrance of the Study area from mountain is as illustrated below.



3) Flooding analysis

Taking land elevation, surface flow direction, actual river channel, etc. into account, the Study area is divided into 27 blocks for the sake of making simulation study on how flood and subsequent land inundation take place according with respective flood discharge. Inundated area expands gradually, and inundation remains for long time at lower lands due to their poor drainage capacity. The inundated area with submergence deeper than 30 cm and the inundation period for more than 24 hours is as given below.

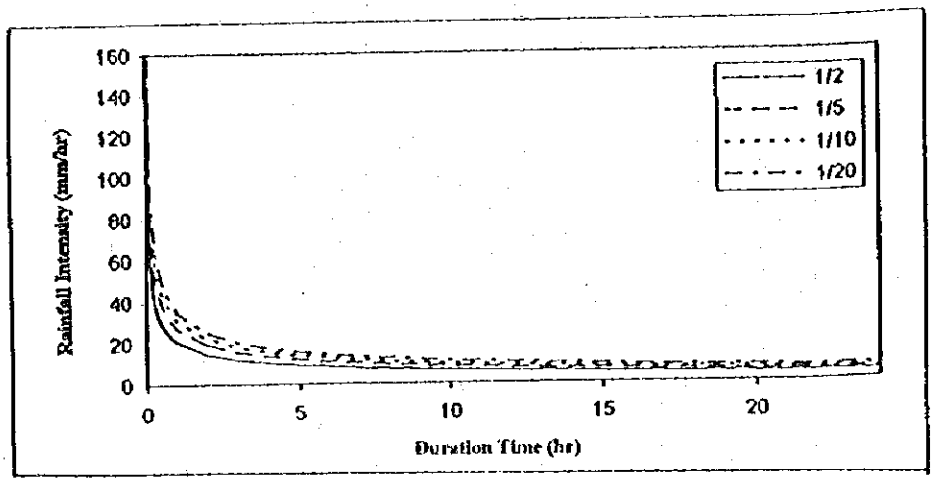
Return Period	Maximum Submergence Depth (m)	Inundation Area (ha)	
		In Total	Paddy Field
1/2	0.99	49	49
1/5	1.12	207	146
1/10	1.21	236	152
1/20	1.28	348	257

(4) Influences of intensive rainfall within the Study area

The flood discharge analysis was made with respect to occurrence of intensive rainfall within the Study area, provided that normal flow is discharged at the river.

1) Rainfall intensity curve

Rainfall intensity curve on the respective return period was analyzed as follows;



2) Inundated area

Inundated area within the Payabo river basin block was analyzed making use of the simulation block cited above, meanwhile with regard to the Cascarilla canal basin block the same analysis was made with establishment of new simulation block. As a consequence, inundated area with submergence deeper than 30 cm and the inundation period for more than 24 hours was predicted as follows.

Return Period	Payabo River Block			Cascarilla Canal Block		
	Max. Submergence Depth (m)	Inundated Area (ha)		Max. Submergence Depth (m)	Inundated Area (ha)	
		In Total	Paddy Field		In Total	Paddy Field
1/2	0.69	0	0	0.23	0	0
1/5	0.78	0	0	0.45	0	0
1/10	0.82	43	0	0.56	41	0
1/20	0.84	68	0	0.64	41	0

3.12 EXISTING SOCIO-RURAL INFRASTRUCTURES

3.12.1 Road

Main roads connecting principle villages are relatively well maintained. However, these roads, being constructed within wetlands, have been gradually subsided since their

construction. As a consequence, the level of some sections of these roads becomes lower than that of the paddy fields producing frequently puddle on their surface.

Farm roads are insufficient in terms of length and they are in precarious condition; besides some roads are considered to have never been maintained since construction.

Presently, there is only one bridge over the Yuna river (constructed at La Reforma) to unit the Study area with other areas , although construction of new bridge to connect Villa Riva with La Ceiba de los Pajaros is underway (it is envisaged that this construction works will complete in 1995).

3.12.2 Communication

In the Study area, there is no telephone system installed, so communication with other part of the area is usually made by radio systems found in the villages of Guaraguao, La Reforma, Barraquito and Paraguay and in the military camp. In an emergency, inhabitants in the area tend to go to Villa Riva to use a telephone.

3.12.3 Electric Supply System

An electric line is served to such rather large villages as La Reforma, Barraquito, Guaraguao and Paraguay; besides small village of Loma de la Ceiba is benefited by an electric service is covered because a pumping station for water supply is operated there. Villages along the Yuna river use an electric system provided through wiring extended from an opposite side of the river. There are 6 power generation systems at Los Peinadores. About 40% of inhabitants pay RD$ 30.00 per one light bulb for use.

3.12.4 Water Supply System

There are two pumping stations at Guaraguao and La Cueva; the former supplies water to only Guaraguao village (most of beneficiaries of this system are those who live in Villa Riva), while the latter service area covers three villages composed by Paraguay, Barraquito and La Reforma. People in other villages take water from well, canals and river for their domestic use.

3.12.5 Health and Medical Services

There are some public and private medical care center or clinic in the area. Serious illness or diseases are treated in hospitals located in Nagua, San Francisco de Macoris, etc.

3.13 ROLE OF WOMEN

The socio-economic survey cited in 3.9.1 has revealed that one for every 10 householders was female, but this does not mean that these women engage in cropping activities; as other

Latin American countries, in the Dominican Republic it is rare phenomenon that women participate in farm labor, in special, for paddy cultivation. In farmlands where female householder holds, cropping activities are conducted by male family members and by hired laborers. Although female householders do not work at farm, there are some farmers who hire female farm laborers; according to the research report (DIFERENCIACION Y ADAPTACION EN LA PRODUCCION DE ARROZ) conducted by CENDA (North Zone Agricultural Development Center) in 1984, 5 of 32 surveyed farmers hired 12 female laborers in total for paddy cultivation; work categories participated by these female laborers were exclusively transplanting and threshing. From that time on mechanization of farming activities is accelerated and the great majority of farmers entrust harvest work including threshing to contractors, it is supposed that less job opportunity is left for female laborers.

Apart from paddy cultivation, there is one female owner of the rice mill in the Study area who engages rice processing activity by herself.. Another example of women's labor in the area is to operate retail shop, to sell vegetables and fruits, etc. Income earned by these labor serves to support household economy of farmers.

Villages in the area are generally allocated taking into account of the convenience for distribution of domestic water, but there are some villages which inhabitants are compelled to make washing of clothes in irrigation canals. On the other hand, the trunk roads to unit villages are cut in part due to the installation of irrigation canals and this situation constrains women and children from passing without difficulty. In view of ameliorating living circumstances of women, improvement of these infrastructure is essential.

3.14 ENVIRONMENT

3.14.1 Administrative Organization

There are no organizations such as a "Ministry of Environment" exclusively responsible for environmental protection issues in the country at present. However, there are some government organizations which have sections or departments that are dedicated to environmental issues and policies. These organizations together with the scopes of their services are as given hereinafter.

1) Department of Environment, ONAPLAN

Services: Participates in planning environmental policies and jointly coordinates environmental services of private and public sectors.

Activities: Formulates guidelines for environmental protection.

2) Watershed Management Program, INDRIII

Services: Manages and monitors the watershed of the Nizao river.

Activities: Conducts surveys on the preservation of the watershed of Nizao River (bamboo planting on the river dikes to prevent soil erosion).

3) Department of Wildlife, SEA

Services: Endeavors to achieve balance between wildlife preservation and state development activities.

Activities: Conducts activities for the conservation and protection of wildlife and the national bird "Dulus Dominicus".

d) Department of Environmental Education, SEA

Services: Promotes educational programs on environmental issues

Activities: Educates farmers, students and teachers on relevant environmental issues. Educates farmers on the proper use of agricultural fertilizers.

e) National Bureau of Parks, DNP

Services: Preserves areas with rich natural resources, areas of historical importance, and recreational areas.

Activities: Preserves and manages 13 national parks 9 development restricted areas.

f) National Bureau of Forestry, DNF

Services: Forest preservation, protection and supervision

Activities: Sanctions forest management activities for the preservation of natural resources.

3.14.2 Rules, Regulations and Guidelines

(1) Environmental regulations

There are no general laws and ordinances on environmental issues in the

Dominican Republic at present. However, an environmental protection bill has been to Congress, and Article 220 of this bill covers the environmental impact assessment (EIA) system.

There are also no laws pertaining to the use of water in the country. INDRHI is the agency responsible for water related issues.

The basic policies concerning water use and water quality preservation are stipulated from the 28th - 35th articles of the bill on "Protection and Environments Quality Law". The implementation of water resource development projects require Presidential authorization.

(2) Environmental impact assessment (EIA)

As previously mentioned, Article 220 of the bill on "Protection and Environments Quality Law" stipulates the implementation of EIA on any project with possible environmental impacts. The enactment of the bill will impose the implementation of EIA on large scale agricultural development projects.

Articles 221 and 223 respectively defines the required EIA activities and the details of EIA. The entries in the appraised report should be mentioned and is therefore enumerated below.

a. Contents of the project
b. Outline of the project area
c. Adverse environmental impacts of the project and measures to control these impacts.
d. The natural environmental impacts of the project
e. The social environmental impacts of the project
f. EIA factors and implementation method
g. Methods to mitigate adverse impacts
h. Monitoring works after project completion
I. Plans formulated in consideration of existing laws and regulations
j. Project alternatives

(3) Regulations on agricultural chemicals application

Presidential Decree 217-91 stipulates the following:

- Prohibits the importation, manufacture, sales and distribution of 20 kinds of agricultural chemicals, e.g., Aldrin.

- Delegates the management of the private sector to SEA for the enforcement of the law.

- Authorizes SEA to promote the development of varieties highly resistant to diseases so as to reduce agricultural chemical application.

3.14.3 Environmental Condition in Project Area

(1) Social environment

1) Inhabitants:

According to the 1994 statistics, the project area has a population of 16,692 and a population density of 116.9 people/km². In comparison with the average national population growth of 2.3%, the annual population growth rate in the area for the past 10 years is only 1.1%.

The population of the area is a mixture of indigenous people and immigrants. There are no conflicts between the two as a lot of the immigrants come from neighboring areas. The population is predominantly indigenous, albeit the presence of Haitian settlers in the area to be submerged for the construction of a flood control dam at the Payabo River; these settlers migrated to the area to work in sugar cane plantations. This minority group will not impede the implementation of the project as they have assimilated to the ways of the local people.

2) Environmental pollution from agrochemicals:

Exclusive of Fastac (Alpla-Cypermethrin) and several others, the agrochemicals used in the area contain low fish toxins, are not residue-prone agrochemicals in crop and are less likely to result in biological magnification. Further, these chemicals can be hardly considered as environmental pollutants as their application is kept in small doses.

It is feared that the occasional large scale aerial spraying of agricultural chemicals in the area will cause contamination when followed by rainfall. Aerial spraying is carried out 5 times (once for herbicide and 4 times for insecticide) within the first cropping period at an area of 25,000 tareas (1,563 ha), in the project area.

3) Endemic and Epidemic Diseases:

There are no endemic diseases like Malaria in the area.

4) Domestic Waste Disposal:

Ninety percent (90%) of the population is presently equipped with pit latrines, a practice that helps prevent river water contamination. Difficulties in domestic waste disposal are not expected in consideration of

the low population density and vastness of the area.

5) **Historic and Cultural Relics:**

There is nothing of anthropologic, antiquarian, artistic, cultural, historic or ethnologic importance in the area. Adjacent to the project area, however, is the National Park "Los Haitises".

(2) Natural Environment

1) **Endangered Ecosystem:**

There are no endangered species in the area as the wetlands (ponds, swamps and marshes) do not fall under the category stipulated in the Ramsar Treaty. However, these areas are famous as either habitats of snapping turtles or landing areas of migratory birds.

2) **Forestry**

There are no large forest areas in the study area. Forests only constitute 11% of the area. A mangrove forests exists within the national park, "Los Haitises", adjacent to the project area.

3) **Topography, geology and soil**

The area has a low-lying topography and a geology made up of humic soil, clay and marine sediments. Soil quality is predominantly clayey.

Forests only cover a very small part of the project area, which is mostly made up of paddy fields or grasslands. The whole area is covered with vegetation and free from soil erosion problems.

The adjacent Haitises mountain range and the mangrove forests at the downstream river coasts of Yuna River and Barracote River are designated as a National Park. Vegetation is carried out in the area to preserve the natural environment. Soil erosion problems hardly arise in the upstream areas of Payabo River where the Dole pineapple plantation is located.

3.14.4 Water Quality Condition in the Project Area

(1) Objectives of the survey

- To determine whether the water quality of springs and rivers are suitable for irrigation use.
- To determine the extent of pollution in the rivers and canals due to

agrochemical use.

(2) Survey area and frequency

Sampling was carried out at ten (10) stations (8 stations within and 2 stations outside of the project area). Four (4) of the eight (8) samples were taken from springs, three (3) from rivers and one (1) from a drainage canal is shown in the table below. The sampling stations are shown in Figure 3.14.1.

Study Points	Rivers/Springs	Frequency of Sampling
1	Payabo River (Upstream)	5
2	El Guaraguao (Upstream)	3
3	La Cueva	3
4	Lagunita Cristal	2
5	Laguna Cristal	2
6	Payabo River (Downstream)	5
7	Cascarilla Drain	5
8	Yuna River	4
9	Nagua River	1
10	Caño Colorado	1

(3) Items to be analyzed and analyzing method

1. EC	2. pH	3. DO	4. DO (%)
5. Temperature	6. Redox	7. Salinity	8. Ca
9. Mg	10. Na	11. K	12. Co3
13. HCO3	14. SO4	15. Cl	16. SS
17. RaS	18. Clase	19. N-NO3	20. N-NO2
21. N-Kjeldal	22. TP	23. Total Coliform Group	24. Fecal Coliform Group

25. Hg
26. Agrochemical items (Insecticides: Triclocfon, Fenetrothion, Monocrotophos; Herbide: Bentazone, Propanil, Butachlor

2) Water quality analysis

Water quality analysis, exclusive of agrochemical content in water, was carried out at the INDRHI laboratory using the APHA (1989) method. Since agrochemical analysis was difficult to conduct in the Dominican Republic, it was carried out in Japan by: (1) condensing the samples taken in Nagua in Sep-pak cartridges by means of the vacuum system (see Figure 3.13.2), (2) carrying the cartridges to Japan. Agrochemical content analysis was conducted by means of gas chromatography-mass

spectrometry.

(4) Water quality analysis results

The results of the water quality analysis are shown in Table 3.14.3 and Figure 3.14.3. The quality of the water presently used for irrigation was classified in accordance with the US Salinity Laboratory Irrigation Water Classification Diagram by Thorne and Peterson (1964), which is incorporated in the agricultural handbook published by the United States Ministry of Agriculture (Figure 3.14.4). The classification is based on the following parameters: 1) total concentration of soluble salts, 2) relative proportion of sodium to other cations, 3) concentration of boron or elements which may be toxic, 4) sodium absorption ratio ($SAR=Na^{+} / \sqrt{[(Ca^{++} + Mg^{++}) + /2]}$) when deemed necessary.

The water quality of springs and rivers is considered suitable for irrigation use as it was classified under [C2-S1]or [C1-S1].

Six (6) of the widely used agrochemicals (insecticides and herbicides) in the project area where selected for analysis. And the results show that not all of the water samples contained agrochemicals, mainly because the survey was carried out in February, the fallow period, when only a small amount of agrochemicals, or none at all, is applied. Accordingly, the survey results proved that agrochemical use has very little impact on the environment.

(5) Annual changes in water quality

The water quality of the following rivers in the area, as analyzed in the past, is shown in table below.

Sampling Points	Sampling Period	Sampling Frequency
El Guaraguao	Oct. 11/79 - May 22/80	3
Yuna River (Villa Riva)	Apr. 8/80 - Mar. 25/85	18
Yuna River (El Limon)	Jan. 20/81 - Mar. 25/85	25
Payabo River (Abadesa)	May 23/79 - Nov. 20/86	35

The table shows that the water quality of these rivers is suitable for upland irrigation as they fall under [C2-S1] or [C1-S1].

The annual changes in the water quality of Yuna River (El Limon) and Payabo River (Abadesa II) are shown in Figure 3.14.5. Annual changes in river water quality cannot be determined from the concentrations of Ca, K and Na alone.

3.15 ACTUAL SITUATION OF AGLIPO I (EL POZO) AREA

Construction works for development of infrastructures for the AGLIPO I (El Pozo) Project was completed in 1990 and five years have passed since then. In the

meantime an improvement works were implemented for some, while some blocks accounting for close to 1,000 ha have never been sowed rice seed up to date. Anyway, vast paddy fields extend over the area promising farmers increased farm income together with ameliorated standard of living and this scene is impressive if one contrast the area with its situation before completion of development works, when swampy lands had been left in vain without using them for productive purpose. So as to make better use of experience in this El Poze Project to the Limon del Yuna project, subjects to be reflected are resumed.

3.15.1 Planted Area and Output of Rice

According to the rice production plan of AGLIPO I project, the year of 1995 corresponds to the final year of the mid-term target. Comparison between the projected output and the actual output is shown below:

	Mid-term Target(1990~1995)			Long-term Target (1995~)			Actual Product (1995)		
Land Elevation (masl)	Yields (t/ha.)	Area (ha)	Output (t)	Yields (t/ha)	Area (ha)	Output (t)	Yields (t/ha)	Area (ha)	Output (t)
> 2m	4.0	5,800	23,200	5.5	5,800	31,900	5.0	5,000	25,000
2~0.6m	3.0	4,200	12,600	4.0	5,600	22,400	3.7	3,400	12,580
< 0.6m	2.4~2.7	2,200	5,600	2.7~3.7	3,600	10,250	2.5	1,200	3,000
Total		12,000	41,400		15,000	64,550		9,600	40,580

The above comparison has revealed that the actual output is very close to the projected one and this result was brought by attaining higher unit yield than the target one; the actual planted area, by contrast, remains almost 80% of the target one. It is supposed that the better productivity was brought by introduction of improved seed varieties and application of advanced cropping technology.

3.15.2 Main Subjects

Main subjects identified through the fields survey are as follows:

(1) Acceleration of regional imbalance

Different land conditions have caused imbalance among irrigable lands of the area; some lands located on the left side of the project area with higher elevation which have been cultivated paddy production for long period have attained double harvest a year contributing to increase of farmers' income, while other lands (approx. 1,000 ha) located on the right side of the project area which were newly put in production of paddy with lower elevation are not sown at present without attaining anticipated output. It is thus suggested to propose measures to improve lands which are incapable to cultivate paddy.

(2) Agricultural credit

It is reported that almost 100 % of the agricultural credit financed by BAGRICOLA is repaid. However, the Bank is not willing to finance to farmers who cultivate less productive lands mentioned above. It is recommended that, apart from land improvement works, expansion of credit services to cover these lands should be realized

(3) Operation and maintenance work

At the time of completing construction works in 1990, INDRHI was turned over machinery and equipment which deemed to use for conducting improvement works of the project, but they have not been use effectively within the project area. furthermore, some of them which are left at present need to be replaced due to their physical deterioration. The great portion of O/M services are concentrated on excavation of canals; sand sedimentation at the tide gate has never been removed since 1990 nor has damaged protecting wall installed at Caño Colorado been rehabilitated; maintenance of road network has never been made satisfactorily. The existing machinery and equipment for O/M services are not sufficient to cover vast extension of the project area, so procurement of additional machinery and equipment is essential.

(4) Water users' association

Beneficiaries of irrigation works had been asking for any kind of O/M services to be conducted by INDRHI before, but they become more conscious of autonomous administration of irrigation works as a result of strengthening of farmers' organization through construction of rice processing complex financed by the Government of Italy together with formation of water users' association (Junta de Regantes) promoted by the Dominican Government.

(5) O/M of pumping station

After completion of construction works (from 1990 on) the electric supply system of the country has become more capricious and, as a consequence, INDRHI installed a generator by themselves to carry out O/M of the pumping station properly.