CHAPTER 4: CONSTRAINTS AND POTENTIALS ON DEVELOPMENT

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4.1 Constraints on Development

The Study area was developed as large-scale agrarian reform project area about thirty years ago with intensive investment on construction of irrigation and drainage works. Since then the area has expected to become a leading rice productive area of the country. Nevertheless, due to the various factors which are pointed out in the Chapter 3, the Study area is suffered from inferior and inconsistent agricultural productivity and , as a consequence, its agricultural activity represented by paddy cultivation is stagnated. To overcome this bottleneck and to attain target development anticipated at the time of project planning, drastic measures to reform these socio-economic and physical conditions of the Study area is highly required.

Constraints affecting the development of the Study area are epitomized as follows.

(1) Physical factors

The Study area is situated within flooded plain of the Yuna river system, and is subject to frequent attack of river flooding accordingly. Flat land topography of the area causes poor drainage and leaves farmlands inundated for longer period. Water resources to be available for irrigation purpose are not abundant and their rational and effective use is of importance. The great majority of lands in the area has been developed, so there is very little virgin land that may be put in farmland.

(2) Institutional factors

Inadequate operation and maintenance of irrigation/drainage works has prevented from distributing irrigation water effectively and improving poor drainage. On the other hand, unsatisfactory institutional services in the field of agricultural credit and extension of crop farming technology is associated with low cropping intensity as well as deterioration of agricultural productivity. Inactive farmers' organization results in dull performance of rural society. In addition, limited farm size distributed beneficiaries of agrarian reform discourages them to expand farming activity.

(3) Economic factors

Under-development of rice processing business within the area disproportionate with paddy production declines to activate local economy through raising value-added of agro-products, accelerating marketing and creating new job opportunity. Inactive farmers' organization cited above is also contribute to hinder competition in such activities as sale of agricultural inputs and rent of agricultural machinery, which constitutes one of elements to raise production cost of crop and animal husbandry.

The above-cited constraints, inter-related each other, are illustrated as shown in Table 4.1. These constraints could be classified according with methodology and difficulty for easing them as well as necessary investment in the following manner.

Those which require support at national level:

- Inadequate credit services of the BAGRICOLA
- Lack of budgetary arrangement for extension service and operation and maintenance of irrigation works
- Difficulty in acquisition of improved seed
- Limited farm size
- Elevated price of agricultural inputs

Those which may be eased by strengthening existing organization or institutional supporting services

- Lack of financial resources to farmers
- Inappropriate system for O/M of irrigation/drainage works and roads
- Deficiency of agricultural machinery
- Absence of proper extension services to farmers; unsatisfactory services to educate farmers in forming organization

Those which require medium sum of investment to be financed by the central government

- Absent of O/M works
- Under-development of road network

Those which require large sum of investment together with sophisticated technology

- Insufficiency of irrigation water and substitution of pumping system
- Flooding damage

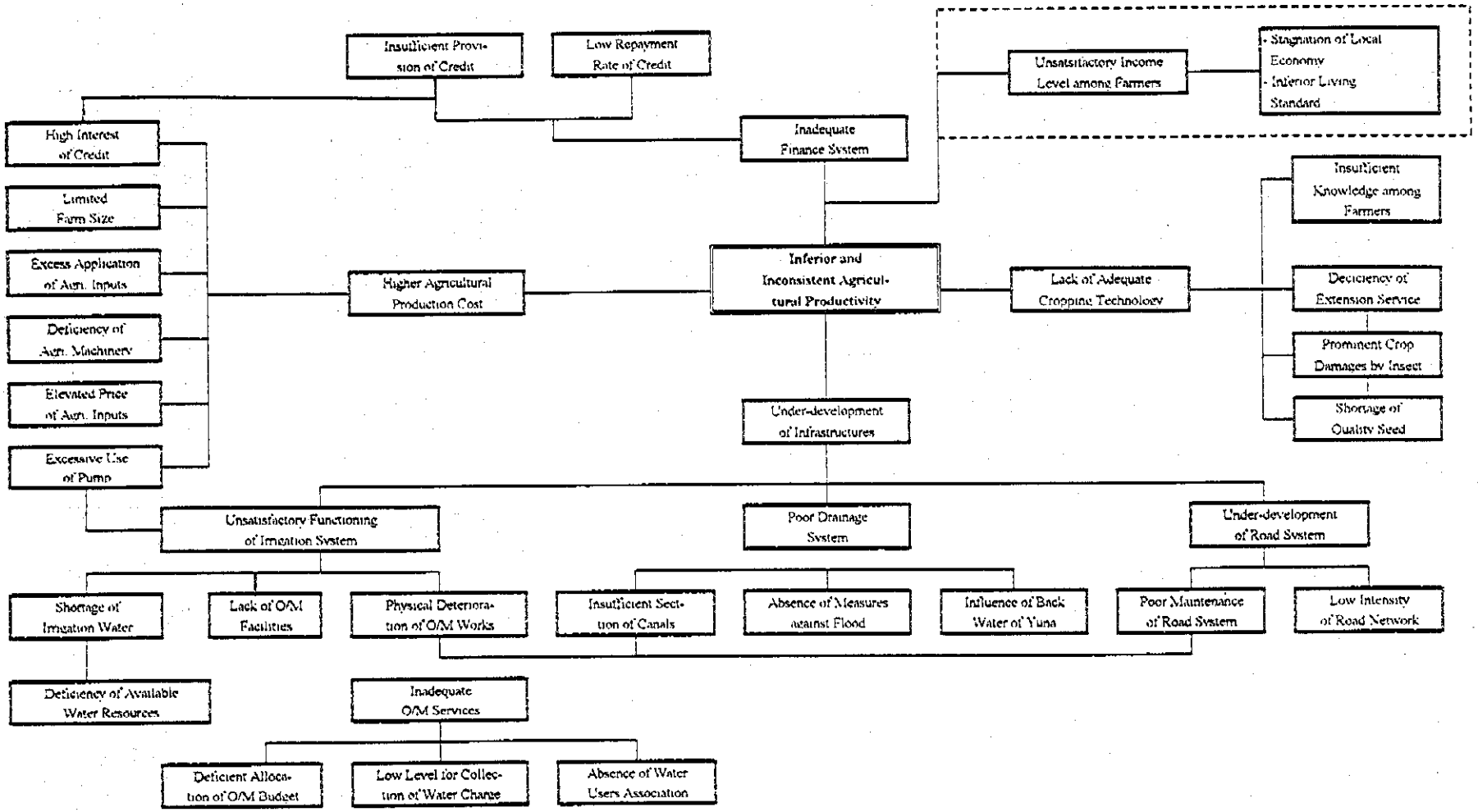


Fig. 4.1 Prevailing Constraints on Development

4.2 Potentials on Development

As explained in the previous section, the Study area is at present under-developed to have been affected by various constraints, but these constraints may be eased if strengthening of institutional services to support farmers and rational use of physical resources are realized. And, as a consequence, an anticipated development of the Study area may come true. Potentials attributable to development of the Study area are as follows.

4.2.1 Institutional Aspect

Irrigation and drainage facilities are already installed in the Study area, so investment required for development of the area can be reduced in comparison with development project without such facilities. In so far as operation and maintenance is concerned, turn-over of irrigation works from INDRHI to associations water users is in progress in other irrigation project areas under the privatization policy of the Dominican Government, the proposal to form water uses' association to entrust the association O/M of irrigation works within the Study area may be facilitated without serious obstacles. Besides, the existence of farmers' organizations, even though they are actually out of function, can promote improvement in marketing and crop cultivation by strengthen their activity.

4.2.2 Land Resources

Clay and similar property soils, which are distributed extensively over the alluvial plain formed by flooding of the Yuna river, are optimum resources for cultivating rice. It is observed that there are some poorly drained lands which are evaluated to be less capable to use for irrigation purpose and some farmlands which are suffered from low productivity affected by poor land drainage, they may be switched to better productive lands putting drainage improvement works into force.

Although it is not probable to convert large amount of virgin land into arable land, the existing grazing lands which occupy greater portion of the Study area may be used as land of more intensive use. Thus land resources present higher adaptability for agricultural development.

4.2.3 Water Resources

Water resources available to irrigate farmlands in the Study are not necessarily abundant, but their rational use will enable to expand irrigable area. Apart from actually available water resources, irrigation water can be taken newly from the Cevicos river in the western sector and from the El Cercado spring in the eastern sector. Although intake method is limited to pumping system, flow of the Yuna river is another resource to be studies its possibility to be used for irrigation purpose. In addition, the use of return flow and construction of reservoir are proposals which are worth while to be studied. Available amount of water for respective water source is estimated as explained hereinafter.

(1) Western sector

The leading source of irrigation water in this sector is the Payabo river. Spring water to flow into the Caño Ponton and the flow of the Cevicos river are another resources to be used; the latter is accumulated spring water which are originated form the mountain, flow down along the western limit of the Study area, and discharge directly into the Yuna river. This resource is not actually used as irrigation water, but is viable to be distributed to the lower zone of the

Ponton irrigation block. Useless flow discharged from the Caño Ponton to the Cevicos river is also available for irrigation purpose by constructing a weir.

1) Payabo River

The low flow of the Payabo river with the return period 1/5 for 24-year observation period 1971-1994 is calculated to be Q = 1.05 m^3/s and multiplying this low flow by the monthly minimum discharge, an available discharge of the Payabo river is obtained as given in the following table.

Unit: m^3/s

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A.M.D.	2.36	2.07	1.70	1.58	2.46	3.96	3.83	4.22	4.56	4.43	3.78	2.96
L.F.	1.60	1.37	1.13	1.05	1.61	2.65	2.57	2.81	3.05	3.01	2.57	1.97

Note: A.M.D. - Average Minimum Discharge, L.F. - Low Flow

2) Spring water flowing into Caño Ponton and the Cevicos river

The spring water accumulated in the Caño Ponton and the discharge of the Cevicos river were estimated as a consequence of river discharge observation and its analysis. the available discharges at these sources become the lowest level in April, which are as given below.

Sources	Available discharge (m^3/s)
Caño Ponton	0.500
Cevicos river	0.600

3) Integrated available discharge in the western sector

Monthly available discharges other than that for April were obtained on the basis of the those of Laguna Guaraguao which is to be indicated in the subsequent sub-section (2).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Payabo	1.600	1.370	1.130	1.050	1.610	2.650	2.570	2.810	3.050	3.010	2.570	1.970
Ponton	0.636	0.513	0.470	0.500	0.750	1.051	0.910	0.937	0.812	0.728	0.816	0.783
Cevicos	0.764	0.615	0.563	0.600	0.900	1.261	1.092	1.124	0.975	0.873	0.980	0.939
Total	3.000	2.498	2.163	2.150	3.260	4.962	4.572	4.871	4.837	4.611	4.366	3.692

(2) Eastern sector

Water resources in this sector is represented by river flow of the Yuna and springs' water found in the southern part of the Study area. Major springs are: Guaraguao, Lagunita Cristal, La Cueva, El Cercado and Laguna Cristal. Favorable correlation between the amount of rainfall in the watershed and the spring discharge is identified in the course of the field study.

The most complete data regarding spring discharge within the Study area coincide with the Laguna Guaraguao where a total of 110 pieces of record observed for the period of 1975-94 are available, although they are not daily data but are of specific date/period. Other springs have fewer observation records. Processing these existing data information on seasonal

variation of spring discharge may be obtained, but not the case with the available discharge to de used for irrigation purpose. Facing with this difficulty, the available spring discharge to be taken for irrigation purpose has been calculated processing spring data of Laguna Guaraguao and rainfall data of the Barraquito station by multiple regressive analysis method.

1) Spring discharge at Laguna Guaraguao

Spring water of Laguna Guaraguao is discharged through the Canal I and the Canal II. More data have been registered with regard to the Canal I, thus the correlation of the discharge at this canal and the amount of rainfall is calculated by means of the multiple regressive analysis in the following manner.

$Y = a + b1 * X1 + b2 * X2 + b3 * X3 + \ldots bn * Xn$ (Formula 4.2.1)

where, Y: spring discharge (m^3/s)

a,bn: coefficient

Xn: rainfall amount at the Barraquito Station (mm)

Through trial and error with respect to Xn, the following formula was presented as technically reliable and highly correlated one between Y(the calculated discharge) and the registered discharge at the Canal I .

$Y = 0.7756 + 0.0028 * X1 + 0.0074 * X2 + 0.0035 * X3 + 0.0014 * X4 + 0.0040 * X5 + 0.0024 * X6 + 0.0062 * X7 + 0.0071 * X8 + 0.0038 * X9 + 0..0066 * X10 \ldots$ (Formula 4.2.2)

In accordance with the following steps, the volume of spring discharge al Laguna Guaraguao has been estimated as given in the table below.

a. To calculate amount of rainfall at the Barraquito station subject to the return period 1/5: (R = 1,773 mm)

b. To select a year which is featured by the representative rainfall pattern among 19 years (the selected year: 1983, R = 2,136.7 mm, Correlated coefficient: 0.906)

c. To convert the rainfall of the year 1983 into that of the return period 1/5

d. To fix the amount of rainfall calculated in above item c. into the Formula 4.2.2 to get the volume of the spring discharge.

e. To estimate global discharge at Laguna Guaraguao on the basis of the ratio of the ratio of registered discharge between the Canal I and the Canal II (Sum of discharge Canal I and Canal II/Discharge of the Canal I = 1.213)

Unit: m^3/s

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Canal I	1.464	1.179	1.080	1.150	1.726	2.417	2.094	2.154	1.869	1.674	1.878	1.800
Canal II	0.312	0.251	0.230	0.245	0.368	0.515	0.446	0.459	0.398	0.357	0.400	0.383
Total	1.776	1.430	1.310	1.395	2.094	2.932	2.540	2.613	2.267	2.031	2.278	2.183

2) Discharge in other springs

Hydrological data on discharge of springs other than Laguna Guaraguao are so scarce that they are not useful to estimate their monthly available discharge. Facing with this bottleneck, the said monthly available discharges were obtained multiplying the coefficient of the discharges at the same period between Laguna Guaraguao and other springs by the monthly available discharge of Laguna Guaraguao. Obtained values are summarized in the table below.

Unit: m^3/s

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
La Cueva	0.519	0.418	0.383	0.407	0.611	0.856	0.742	0.763	0.662	0.593	0.665	0.638
Lagnita Cristal	1.341	1.080	0.989	1.053	1.581	2.214	1.918	1.973	1.712	1.533	1.720	1.648
Laguna Cristal	0.584	0.471	0.431	0.459	0.689	0.965	0.836	0.860	0.746	0.668	0.749	0.718
El Cercado	0.838	0.675	0.618	0.658	0.988	1.384	1.199	1.233	1.070	0.958	1.075	1.031

(3) Yuna River

Drawing water from the Yuna River was studied in the Feasibility Study for the Aguacata-Guayabo Agricultural Development Project, in which water intake level was incorporated to be 7.8 m above river bed and an irrigable area was established in accordance with this intake level. In case that the Yuna River should have available discharge to downstream catchment area once irrigation water for the Aguacate-Guayabo Project will have been taken, some portion of the discharge may be deviated to the Limon del Yuna area.

The low flow with the return period 1/5 at Villa Riva and design intake volume from the same point are as shown below.

Low flow: 16.05 m3/s
Design intake volume: El Pozo Project - 5.50 m^3/s
Aguacate-Guayabo Project - 5.90 m^3/s
Total - 11.40 m^3/s
Available discharge for downstream: 4.65 m^3/s

It is prerequisite to reserve some portion of the said available discharge to the catchment area downstream from the Limon del Yuna area, then around 2 m^3/s of discharge may be taken from the river to irrigate the Limon del Yuna area.

(4) Other water resources

In the dry season, constant shortage of water to irrigate paddy fields is foreseen, so development of water resources apart from above-mentioned ones would be essential to offset the shortage.

The followings are candidates of water resources to be newly developed.

1) **Return flow**

Farmlands located between the Yuna River and the Cascanilla canal are actually irrigated pumping water from the Yuna river. For these farmlands, diversion of water from Laguna Guaraguao is the most economical proposal, but available discharge at this spring is not sufficient enough to supply water to farmlands in question. In this regard, consideration will be made to make use of return flow discharged into the Payabo river. This is a technically viable proposal, although measures to elevate water level is prerequisite.

Similar proposal will be contemplated in other farmlands so far as the conditions permit it; in this proposal saving of irrigation water within small irrigation block is possible on the condition that irrigation and drainage network is designed for receiving return flow.

2) **Construction of a reservoir**

There is a suitable spot at the confluence of Laguna Guaraguao and the Payabo river for construction of a reservoir. The construction of a reservoir pretend to store excess water of Laguna Guaraguao at the time of high water period or at the time when less irrigation water is distributed to paddy fields, and to discharge stored water in the dry season. The relation among irrigable area, storage volume and reservoir area is given in the following table. Reservoir with water level higher than 13 meters above sea level is not technically recommended.

Irrigable area (ha)	300	400	500	600	700	800
Storage volume (m^3 x 000)	1,344	1,880	2,417	2,950	3,660	4,400
Water level (m)	10.9	11.3	11.6	12.0	12.5	12.9
Reservoir area (ha)	120	140	145	152	160	170

(5) Available water resources

Although the development plan of water resources an availability of the same was assessed herewith, will be established within the section 5.6.2 "Irrigation plan" once the relation between available discharge and irrigable area will have been studied, it is preliminarily concluded that the Study area has enough water resources to serve for solving prevailing shortage of irrigation water.

4.3 Development Strategies

4.3.1 Principles on Formulating Development Plan

The agrarian reform project carried out in the Study area had converted extensive swamp lands into productive paddy fields, but deteriorated irrigation and drainage conditions taken place in the course of 30 years has compelled some of these paddy fields to be used as rough grazing lands or uplands against their land capability as well as to rely on pumping system to take irrigation water. On the other hand, some undulated lands with higher elevation have been used exclusively for grazing lands from initial stage of the agrarian reform project without being switched into paddy fields. In relation

with flood mitigation, no measures but elevation right margin bank of the Payabo river has been put into implementation. With only land development works conducted gradually and road maintenance works, the operation and maintenance services as a whole are behind the deteriorating pace of infrastructures. Private lands located along the Yuna river have never been benefited by development of infrastructures. It is thus timely to touch with the Study area by means of improvement and development of infrastructure and strengthening of institutional services to farmers so that anticipated prosperous society may be realized in the Study area.

In formulating agricultural development plan of the area, the higher priority shall be given to promoting paddy production taking the Study area's climatological conditions, land and water resources potentials and prevailing farming practice and socio-economic circumstances established by this farming practice together with future forecast for supply and demand of rice at the national level into account.

In line with this principal, an expansion of cultivated area of paddy will be envisaged within the agricultural development plan in accordance with the following basic concepts.

As estimated in the analysis of present land use, the Chapter 3, the total sum of arable lands in the Study area accounts for 9,350 ha, and the present Study pretends to expand paddy field as much as possible after alienating the following lands.

a. Actual paddy fields alongside the Yuna river which are irrigated by pump

Actual paddy fields which are located in higher lands and are not be irrigated by gravity (most of them are situated along the Yuna river): approx. 110 ha

b. Uplands with smaller farm size without being irrigated by gravity

Some uplands totaling 30 ha which are situated at Cristal village are not benefited by gravity irrigation due to their elevation 6 meters higher than the nearest intake point. Distribution of irrigation water from far intake point is not recommended from economical point of view. These lands will be excluded from irrigable area if pumping irrigation will not be employed. Another uplands with similar situation (approx. 90 ha) will also excluded.

c. Large private farmland which is administrated under intensive farming system

A large private farmland occupying approximately 100 ha is used for intensive production of plantain; this farmland is located in higher elevation and isolated from paddy fields. It is recommended that this farmland will remain as it is in the future.

d. Rough grazing lands not suitable for conversion into paddy field

Close to 18% of actual grazing land, which are found in topographically limited condition such as bordering upon mountain and rivers, are considered to be not suitable for their use as paddy field under forming irrigation block.

With alienating these lands, the maximum extension of paddy fields will become 8,680 ha in total.

In the following cases, on the other hand, expansion of paddy fields shall be limited, although conclusion of the theme shall be drawn after making more detailed study in the Phase II of the Study.

a. Water resources are not sufficient enough to incorporate drastically new paddy fields.

b. The cost-benefit analysis concludes that an internal rate of return to be expected by expansion of the area is less than the actual situation.

The expansion of paddy fields is envisaged in such lands as are actually suffered from low productivity, so proposal will promise to improve their productivity per hectare of land.

Farmlands in the Study area consist of national lands distributed to settlers and privately owned lands; the former has been fully devolved, therefore there remains very little virgin which may be put into arable land. This situation leads to suggest that an expansion of paddy fields should be made either of the following two alternatives: 1) To purchase private large lands by the government and 2) To expropriate one-quarter of land applying "Quota part law" among beneficiaries of irrigation and drainage system improvement. The latter alternative enables to dispose approximately 400 ha of farmlands to be distributed to some 100 farmers.

4.3.2 Development strategies

Of constraints affecting the development of the Study area, shortage of irrigation water and flooding require the most sophisticated technology and vast investment to ease them. Without achievement of this target, institutional services to support farmers would not be provided in a satisfactory manner even if they are strengthened. On the other hand, so as to realize anticipated functioning of infrastructures in parallel with attaining target agricultural production, solid organization of farmers is essential. In addition, in view of actualizing sustainable agricultural production and construction ameliorated society an agricultural development plan should be designed with special attention paid to environmental aspects. It is also suggested that the executing agency of the project should take redistribution of farmlands among small farmers into account so that they could live satisfactorily upon earning of their farming.

The Limon del Yuna Area Agricultural Development Plan shall be formulated in line with the following strategies'

1. In planning irrigation system priority will given to gravity intake and distribution system from standpoints of saving construction and O/M cost and convenience in O/M services, while pumping irrigation will be evaluated its possibility only when this system excels the gravity system in expected cost-benefit ratio.

2. Drainage improvement plan will have an objective to serve enhancement of land productivity in paddy fields and grazing lands which are suffered from poor drainage being located near the mountain, to the south of the Study area.

3. Flood related measures will be delineated in such manner as to mitigate damages to agricultural production as small as possible. Relevant civil works will be designed after studying the relation between construction cost and expected effect.

4. Roads development planning will be made as follows: trunk roads will not be touched but to improve their surface unevenness; secondary roads will be improved in such grade as to permit access of heavy machinery and vehicles.

5. Marketing and processing plan of agro-products development plan shall be proposed in due compliance with agricultural production plan.

6. So far as farmers organization is concerned, proposal will be made to form newly an organization affiliated by beneficiaries of irrigation system (water users' association) and to strengthen existing farmers' organization (cooperatives).

7. Recommendations will be provided as regarding institutional services to farmers (agricultural credit and transfer and extension of cropping technology).

8. In planning infrastructures considerations shall be made in alleviating negative effect of their development on environmental issues.

Summing up, the Limon del Yuna Area Agricultural Development Project to be formulated in conformity with the above-cited strategies aims at reforming the Study area which will enjoy an enhancement of the situation supported by "Higher and More Sustainable Agricultural Production" (Refer to Fig. 4.2). Detailed development plan for respective sub-project is presented in the Chapter 5.

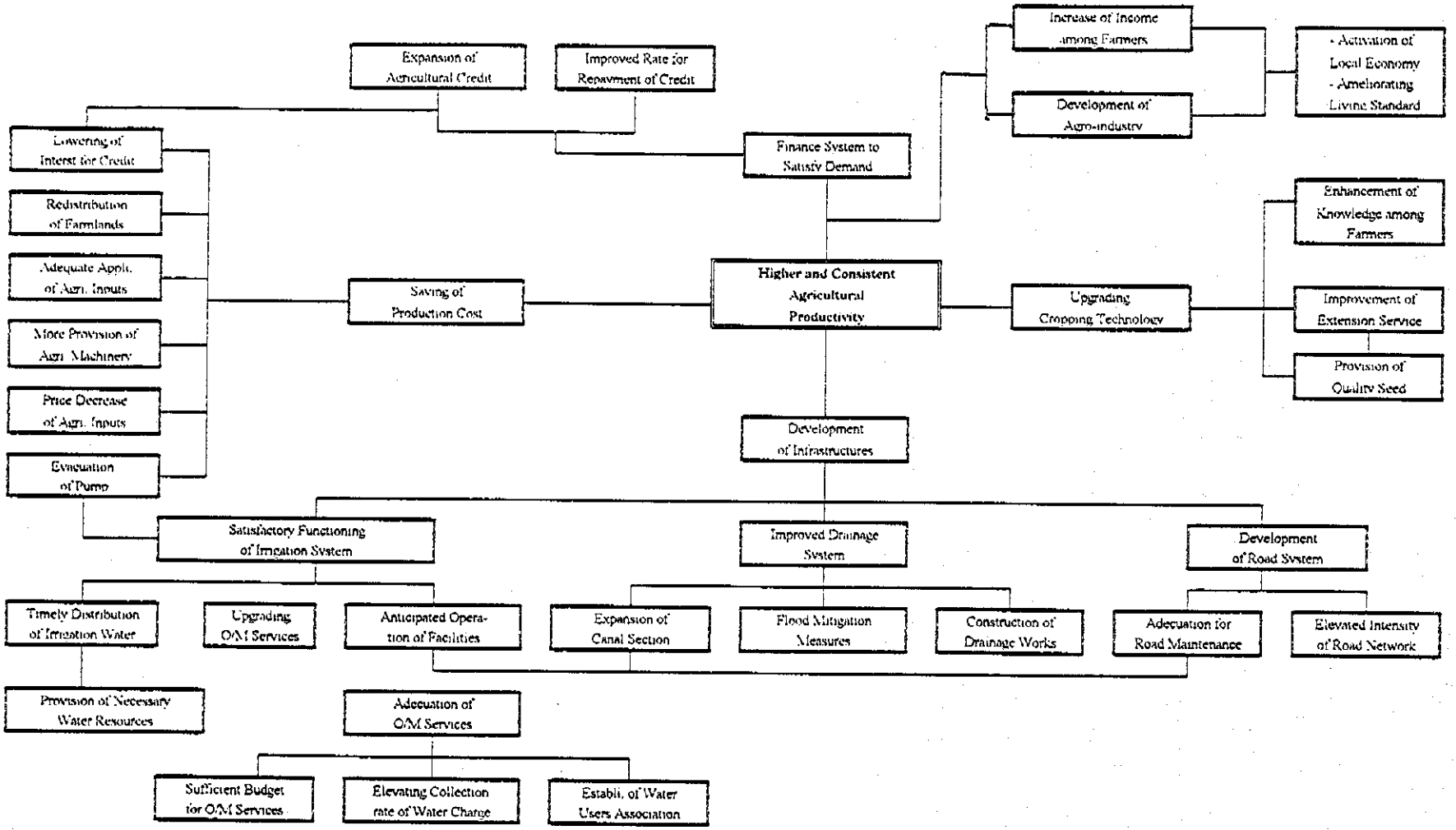


Fig. 4.2 Development Targets of the Study Area

CHAPTER 5: FORMULATION OF THE DEVELOPMENT PROJECT

CHAPTER 5: FORMULATION OF THE DEVELOPMENT PROJECT

5.1 OBJECTIVES OF THE PROJECT

The Government of the Dominican Republic had formulated the AGLIPO Agricultural Development Project with an objective to make an intensive use of about 25,000 ha of land extended over the lower basin of the Yuna river as paddy fields, and as a first phase of the said project the development works were completed at the El Poze area (northern part of the AGLIPO project area) in 1990 and the second phase of the AGLIPO project is scheduled to start in the coming 1996 at Aguacate-Guayabo area, located in the central part of the project area. In so far as the Limon del Yuna area is concerned, it is expected that this area is also benefited by development in the near future as the third phase of AGLIPO project. With completion of these three phased development, the AGLIPO area will become virtually the leading paddy productive area of the country supported by higher and consistent productivity.

The Study area is considered to be one of the major agricultural production zone of the country and close to 70% of its territory is represented by agrarian reform project area. The only practical proposal for the area to attain anticipated growth shall be encouragement of the agricultural sector and, in this sense, the present Study aims to ease constraints presented in the Chapter 4 and to formulate an agricultural development plan which will serve to attain the following targets.

- To take part in the development of the AGLIPO area attributable to realization of high-productive agricultural zone
- To establish farming system to promise farmers with consistent crop yield and satisfactory income
- To strengthen rural organization to contribute to rationalization of farming, marketing, and operation and maintenance of irrigation/drainage system
- To ameliorate living standard if farmers and to encourage performance of local economy

And, in pursuit of the said targets, the measures to be taken are as listed below.

- Acquisition of irrigation water to enable double cropping of paddy a year
- Mitigation of flooding damage
- Improvement of road network
- Promotion for organization of farmers
- Expansion of marketing and processing facilities
- Upgrading credit services to farmers

- Strengthening of transfer and extension services of cropping technology

5.2 ALTERNATIVE PLANS ON DEVELOPMENT

5.2.1 Premises on Presentation of Alternative Plans

In principle, alternatives plans have been prepared in two categories taking the following premised into consideration.

(1) Deficiency of irrigation water

Actual paddy fields have been expanded beyond consistent irrigable area and, as a consequence, more paddy fields tend to rely on pumping system to take water for irrigation purpose. The first planting of paddy is not faced with shortage of water, meanwhile to supply constantly irrigation water for the second planting, renovation of existing irrigation system is indispensable.

(2) Support to small farmers and land tenure

27 years have passed since the beginning of the agrarian reform project and during the course of this period, division of farmlands which have been distributed to settlers is taken into effect. At present, there are very little virgin land which may be available for distribution of farmers. The land tenure study has disclosed that there are about 100 farms, which are inferior to 2 ha in size (1.6 ha on average). It is supposed that an minimum farm size to promise farmers with desirable living standards would be around 3 ha; so as to eradicate farmers with farmland holding smaller than 3 ha from the Study area, it is necessary to dispose about 200 ha of land, and in this context, it is advisable to comprise large farms in the development plan. With erradication of small farmers with holding smaller than 3 ha, which will enable these farmers to realize more consistent agricultural farming , the O/M services for irrigation system to be undertaken by farmers are expected to be made in more adequate manner.

(3) Electric supply system

The electric supply system in the Dominican Republic has been confronted with the serious problem that constitutes a bottleneck in operation of pumping system at irrigation project areas. Therefore, special attention should be paid in inclusion of pumping system in planning irrigation system.

(4) Improvement of irrigation/drainage system to facilitate organization of water users' association

As a measure to realize an effective and rational use of water resources as well as to attain consistent agricultural production, turn-over policy in control and responsibilities of irrigation system from INDRHI to water users' association (Junta de Regantes) is in progress throughout the country. To follow this policy

within the Study area, an improvement of existing infrastructure that permits anticipated functioning of the said association is of necessity.

(5) Different conditions from standpoint of land tenure

Farming conditions are different between (A) Agrarian report project area and (B) Private lands located alongside the Yuna river, so consideration is to be made for respective category of land tenure.

A. Agrarian reform project area:

In this project area, during the course of 30 years after completion of infrastructures for paddy cultivation, lands converted to uplands and grazing lands from paddy fields have increased year by year in line with worsening in irrigation drainage conditions.

In relation with irrigation condition the following phenomena are observed:

a. Paddy fields have expanded beyond irrigable area incorporated at the time of project planning and, consequently, some paddy fields which had been suffered from constant shortage of irrigation water have been shifted to farmlands of other crops.

b. Quarrel about distribution of irrigation water was made among farmers and this situation has accelerated installation of pumps in such lands as have difficulty in getting irrigation water by gravity

c. Inadequate operation and maintenance services have constrained from realizing rational utilization of available water.

Meanwhile, regarding drainage and flooding conditions it is noticed that:

a. Constant poor drainage and swampy lands have been left without being taken necessary measures to solve the problem.

b. Facing with flooding damages caused by the Payabo river, right margin bank of the river was raised 5 meters higher than its original elevation, but this is not an effective measure to alleviate greatly the said damages.

And, the following change is predominant related with land tenure.

a. Division of farmland parcel is in progress and, as a result, imbalance in terms of farm size has taken place among beneficiaries of agrarian reform.

B. Private lands

Private lands extended over alongside the Yuna river had been threatened by flooding of the Yuna rive in the past, but this threat has been relaxed owing to the

measures taken in its upper stream recently. Endowed with land fertility, farmers in these lands enjoy higher production of paddy pumping water from the Yuna river by themselves and discharging excess water to the Cascarilla Canal. No systematic infrastructure has been provided in this sector up to date.

The above considerations lead to the suggestion that the agrarian reform project area should be reconstructed with rehabilitation of deteriorated structures and provision of new system after examining the transformation of installations between the initial stage of the project and actual the present, whereas private lands area should be provided necessary infrastructures. In putting development strategies into development plans special attention should be paid to recent aggravated electric supply condition of the Dominican Republic; pumping system should be put off as far as the circumstances will permit it.

Due to dispersion of available water resources, irrigation blocks formed within the Study area are in small scale and are interrelated each other including their drainage system. In this regard, it is not advisable to plan each irrigation block independently and an irrigation planning to integrate all blocks in one package will be presented accordingly.

5.2.2 Alternative Plans

The present agricultural development plan will be formulated aiming at increasing rice production, and, in this context, attaining an expansion of the cultivated area of paddy together with improvement of productivity is a key factor for the success of the project. Alternative plans to expand cultivated area of paddy may be classified into two categories by utilization proposal of water resources: one is to limit intake method to gravity system (Alternative Plan A) and the other is to allow pumping system in addition to gravity system (Alternative Plan B) ; the latter plan is further divided into two sub-categories (Alternative Plan B-1 and Alternative Plan B-2) according with inclusion or exclusion of large farms. Thus three Alternative Plans are formulated in this Study.

Alternative Plan A:

In this plan water will be taken from water sources exclusively by gravity without relying on pumping system. As a consequence, an expansion of actual paddy fields is not envisaged in this plan due to the consideration that:

The prevailing paddy fields have been developed beyond potential irrigable area to which water is distributed consistently; there are not a few farmlands in which paddy are cultivated taking water through pumping system. Bearing this situation in mind, it is recommended that the extension of paddy fields should be limited to such area as is assured of constant provision of irrigation water as well as is convenient for effective operation and maintenance of irrigation system. The optimum extension of paddy fields to realize this proposal shall be almost the same as the actual extension. Nevertheless, some uplands and grazing lands which are easily accessible to irrigation water will

be converted into paddy fields. Exceptionally, installation of small-scaled pumps will be realized in view of rational water use by means of return flow.

Alternative Plan B-1

This plan pretend to expand double cropping fields of paddy as far as possible with maximum utilization of available water resources employing not only gravity system but also pumping system.

Within the Study area, a total of 1,200 ha of potential lands which may be switched to paddy fields. The principal constraint on expansion of cultivated area of paddy and improvement of productivity is limited availability of irrigation water. Deficient water resources in the upper reach zone of the Study area has prevented the area from conduction efficient water use. Taking water from the Yuna river with pumping system enables technically to increase double cropping area of paddy in the upper zone.

Alternative Plan B-2

This Plan aims to exclude large farms which are located apart from the irrigation blocks from the irrigable area without affecting general planning of the irrigation system.

In principle, large farms should be alienated from development area of the project because their financial capacity will make it possible to solve any problem that confronts them. One block of grazing lands, which are situated near the confluence of the right margin of the Yuna river and left margin of the Payabo river accounting for approximately 310 ha is held by only two owners. This block is separated from the irrigation blocks of paddy fields, so alienation of it form the development area of the project will never have negative effect on tracing canal network and road system.

In spite of this consideration, this block may be included in the development area if the executing agency of the project intend to allot new lands to the existing settlers who desire to expand their cultivated area or to new settlers; with provision of irrigation system in this block land owner are obliged under "Quota Part Law" to offer one-quarter of their lands (approx. 75 ha) that will enable to distribute 3 ha of paddy fields to about 25 settlers.

There are also some private and large scaled paddy fields between the Yuna river and the Cascarilla Canal. These paddy fields are advised to include in the development area based on the following reasons:

a. Prevailing land use is mainly for paddy field

b. Present pumping system installed at the Yuna river should be removed to protect river levee with provision of substitution system, which is beyond length of each farmer.

c. Infrastructures such as canals and in-farm roads have not been provided for these lands, some measures together with water intake facilities should be taken.

d. These lands are integrated with the rest of lands in the Limon del Yuna area.

e. By means of "Quota Part Law" new lands to be distributed to settlers will become available.

5.3 LAND USE PLAN

5.3.1 Land Use Plan Covering the Whole Study area

On the basis of three alternative plans presented above, irrigation plan is formulated (refer to the section 5.6) and land use proposal "With Project" will be as given in the table below.

Land Use	Without Project		With Project					
			Alternative A		Alternative B-1		Alternative B-2	
	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)	%
1. Arable land	9,350	77.9	8,710	72.6	8,530	71.1	8,600	71.7
1.1 Paddy field	6,680	55.7	6,650	55.4	7,860	65.5	7,570	63.1
1.2 Upland	490	4.1	390	3.3	330	2.8	330	2.8
1.3 Pasture	2,180	18.2	1,670	13.9	340	2.8	700	5.8
2. Forest	1,410	11.8	1,410	11.8	1,410	11.8	1,410	11.8
3. Wetland	80	0.7	70	0.6	70	0.6	70	0.6
4. Wasteland	20	0.2	0	0.0	0	0.0	0	0.0
5. Spring	60	0.5	60	0.5	60	0.5	60	0.5
6. River	130	1.1	150	1.3	150	1.3	150	1.3
7. Resident Area	290	2.4	290	2.4	290	2.4	290	2.4
8. Others	660	5.5	1,170	9.8	1,490	12.4	1,420	11.8
9. Reservoir	0	0.0	140	1.2	0	0.0	0	0.0
Total	12,000	100.0	12,000	100.0	12,000	100.0	12,000	100.0

5.3.2 Development area

The improvement of irrigation and drainage system contemplated in the present agricultural development project will bring the following shift of land use from the actual situation.

(1) In due compliance of the objective of the present project, paddy fields will be maintained the status quo as far as possible, although about 110 ha of lands located at too high elevated to receive irrigation water by gravity will be shifted to uplands. And, another 430 ha will be scarified by improvement of irrigation and drainage system.

(2) The upland area which may be converted into paddy field will be 210 ha (intake of irrigation water exclusively by gravity) and 270 ha (pumping irrigation system is considered in addition to gravity system); the scarified

area for construction of irrigation system will be 30 ha for the former and 40 ha for the latter.

(3) In so far as the pasture which comprises a total extenuation of 2,180 ha is concerned, a maximum of 1,840 ha may be used as irrigable area of paddy field, of which 1,460 ha can be used as net cultivated area of paddy after deducting 380 ha as lot for infrastructure (Alternative Plan B-1). Meanwhile, convertible area to paddy field will be 370 ha in the Alternative A and 1,480 ha in the Alternative B-2, respectively.

(4) Some areas of wetland (10 ha) and wasteland (20 ha) will be put into arable land where paddy will be planted.

(5) Summing up, the extension of paddy field will be expanded to 7,860 ha in the Alternative Plan B-1 and 7,570 ha in the Alternative Plan B-2, whereas a slight decline in net area is contemplated in the Alternative Plan A because sacrifice to the lot for infrastructure.

The above land use plan within irrigable area is summarized in the table below. The total area of 8,820 ha is defined as development area of the present agricultural development project.

Unit: ha

Land Use	Without Project	Alternative Plan A	Alternative Plan B-1	Alternative Plan B-2
1. Existing Arable Land	8,790	8,150	7,970	8,040
1.1 Paddy field	6,680	6,650	7,860	7,570
1.2 Upland	270	170	110	110
1.3 Pasture	1,840	1,330	0	360
2. Convertible Land into Arable Land	30	0	0	0
2.1 Wetland	10	0	0	0
2.2 Wasteland	20	0	0	0
3. Lot for Infrastructures	0	670	850	780
3.1 Reservoir	0	140	0	0
3.2 Other infrastructures	0	530	850	780
Total	8,820	8,820	8,820	8,820

5.4 AGRICULTURAL PRODUCTION AND FARMING SYSTEM DEVELOPMENT PLAN

5.4.1 Principles on Formation of the Plan

The agricultural production and farming system development plan is formulated with a view of putting an intensive farming system into force with raising cropping intensity per ha of land. The area covered by the relevant plan shall be 8,820 ha which coincides with the benefitable area by development of irrigation and drainage system. The improvement in irrigation and drainage works envisages to realize double cropping of paddy yearly in irrigable fields which comprise

not only agrarian reforms lands but also private lands located between the Yuna River and Cascarilla Canal. It is proposed that some lands in which paddy rice is actually planted should be shifted into uplands because their higher elevation constitutes negative factor to receive irrigation water by gravity . Uplands and grazing lands, on the other hand, will be switched into paddy fields as far as water can be distributed there by gravity; concerning uplands and grazing lands which will not be benefited by irrigation water shall be used as they are. In addition, some virgin lands and swampy lands totaling approximately 30 ha will be converted into arable land owing to improvement of irrigation/drainage system.

Bearing above proposal into mind, the present agricultural production and farming system development plan is formulated with an emphasis laid on elaborating scenario for increasing and stabilizing of paddy production. The area to be covered by uplands and grazing lands will decrease in line with the development plan, but measures which pretend to mitigate decline in production of crop and livestock production as far as possible will be proposed.

5.4.2 Cropping Area

Referring to the land use plan, the arable lands area within the development area can be summarized as given below (See Table 5.4.1 for detailed information).

Unit: ha

Land Use	Without Project	With Project		
		Alternative A	Alternative B-1	Alternative B-2
Paddy field	6,680	6,650	7,860	7,570
Upland	270	170	110	110
Pasture	1,840	1,330	0	360
Total	8,790	8,150	7,970	8,040

The implementation of irrigation and drainage system development project sacrifices some portion of arable lands for construction/expansion of canals and other related structure, so the net area of arable lands in "With Project" situation will be reduced in comparison of that in "Without Project" situation. Nevertheless, with improving cropping intensity, the cultivated area "With Project" situation will increase by 30% for the Alternative A, by 39% for the Alternative B-1, and by 37 % for the Alternative B-2 in comparison with the "Without Project" situation. Thus, the cultivated area for respective alternative of the "With Project" situation will become as given below.

Alternative Plan A

Unit: ha

Crops	Without Project			With Project			-
	1st Crop	2nd Crop	Total	1st Crop	2nd Crop	Total	Balance
Paddy	6,000	3,500	9,500	6,650	6,650	13,300	3,800
Upland Crops	65	65	130	170	170	340	210
Pasture	1,840	-	1,840	1,330	-	1,330	-510
Total	7,905	3,565	11,470	8,150	6,820	14,970	3,500

Alternative Plan B-1

Unit: ha

Crops	Without Project			With Project			-
	1st Crop	2nd Crop	Total	1st Crop	2nd Crop	Total	Balance
Paddy	6,000	3,500	9,500	7,860	7,860	15,720	6,220
Upland Crops	65	65	130	110	110	220	90
Pasture	1,840	-	1,840	0	-	0	-1,840
Total	7,905	3,565	11,470	7,970	7,970	15,940	4,470

Alternative Plan B-2

Crops	Without Project			With Project			-
	1st Crop	2nd Crop	Total	1st Crop	2nd Crop	Total	Balance
Paddy	6,000	3,500	9,500	7,570	7,570	15,140	5,640
Upland Crops	65	65	130	110	110	220	90
Pasture	1,840	-	1,840	360	-	360	-1,480
Total	7,905	3,565	11,470	8,040	7,680	15,720	4,250

5.4.3 Rice Cropping Plan

(1) Farming system improvement plan

Although a year-round cultivation of rice is possible so long as water is available, the yield and the growing period vary according to cropping season which is highly influenced by two factors, photoperiod and temperature. A season is considered most favorable for cropping when a maximum double cropping production can be achieved, and is determined based on these factors. If possible, the paddies should be made to rest for as long as possible from any activity between the second cropping and the next season's first cropping for the repair of irrigation facilities and the insulation of the sources of diseases and insect pests. A balance in the supply and demand with respect to work and manpower should be established as well. The desired duration for every seeding, transplanting and harvesting work is a minimum of 50 days.

The rice double cropping plan will be formulated based on the above conditions and as indicated in Figure 5.4.1. The table below sums up the working period based on the cropping plan.

Work	First cropping	Second cropping
Seeding on nursery bed	from early December to mid January	from early June to mid July
Transplanting	from early January to mid February	from early July to mid August
Harvesting	from early May to late June	from late October to mid December

A half a month delay in transplantation does not affect the total double cropping production: delay in the first cropping increases yield while delay in the second cropping decreases yield.

(2) Rice Cultivation Plan

The cultivation techniques, materials and agricultural implements for production, and the working system, in accordance with the cropping plan, are as follows;

1) Variety : Juma 57 and Isa 40

The cultivation of Juma 57, a high-yielding variety, highly resistant to decease and highly responsive to fertilizer, is becoming so popular that now it occupies about 90% of the rice cropping area in the Study area. However, the cultivation of Isa 40, next good variety, is also recommendable in consideration of preventing the possible outbreak of a disease by specific figures race in case of the monopoly of cropping area by one variety.

2) Seeding and nursery bed

Seed disinfection will be carried out after seed selection by specific gravity with salt solution. Rice seeds forced to sprout will be sown on 1m wide and 10 - 20m long nursery beds surrounded with drains. The nursery bed area will be equivalent to 5% of the paddy field where the seedlings are to be transplanted and the amount to be sown will be equal to 140g/m² of dry paddy weight. The amount of rice seeds required per hectare is 70 kg. The fundamentally established growth period in the nursery bed is 30 days. For direct seeding, the amount to be sown will be set at 100 kg/ha. However, direct seeding is not recommendable if field surface leveling is not properly carried out.

3) Paddy field preparation

Plowing, harrowing, puddling and leveling should be conducted directly prior to transplanting to prevent soil reduction, by using power tillers or tractors after flooding and fertilizer application. Machinery or draft animals are used to drag flat boards to level the field for water management.

4) Transplanting and direct seeding

The regular planting with a spacing of 25cm x 20cm or 30cm x 15cm, which means the transplanting rate of 20-25 stocks/m², is recommendable. One stock contains 3 - 4 seedlings. Stocks will not be planted deeply and the water during the active tillering stage will be shallow.

A drilling interval of 25 cm is recommendable for direct seeding.

5) Fertilizer application

The target fertilizer amount is 100kg-40kg-30kg of N-P-K per hectare. In accordance with the availability of compound fertilizers in the market, the fertilizer amount and application method will be as follows;

(a) 440 kg/ha of 15-15-15 will be applied before transplanting and mixed with soil

(b) 70 kg/ha of urea
- 9 weeks after transplanting (20 days before heading) for 1st cropping
- 8 weeks after transplantating (20 days before heading) for 2nd cropping

6) Weed control

Herbicides are sprayed 2-3 days and 1.5 months after transplanting. Butachlor granule will be sprayed in the first application, while Bentazone granule will be sprayed in the 2nd application. Barnyard millet and wild rice will be weeded out by hand, if necessary. Herbicides will be sprayed in the area where direct seeding was carried out in consideration of the rice growth stage after germination, using the same rules used in transplanting.

Regular planting for transplantating and drilling for direct seeding is recommendable because they enable the use of a rotary weeder, reduce the application of herbicides and consequently contribute to environmental preservation.

7) Plant protection

Benomyl should be used for seed disinfection as it is very effective in preventing Blast and Brown Spot. A mixture of Fenitrothion and Edifenphos or Kasugamaycin will be sprayed 60 days and 90 days after transplanting to control the prevalence of the above mentioned diseases and insects e.g. Rice Cut Worms.

8) Harvest

The use of the combine harvester results in minimum loss during harvesting, better selection and less cracks during threshing. In addition, its working efficiency is very high. Therefore, harvesting work shall be carried out by the combine harvester of contractor.

9) Water management

The water system of the entire area should be adequately managed to prevent water shortage or excessive discharge in the main, secondary and terminal canals. To manage irrigation water discharge according to the growth stage of the paddy within the field level, discharge in the terminal level must be administered by the cooperation of a group of beneficiaries.

(3) Yield prospect and target production

Stable irrigation water supply, improvement of drainage condition and newly introduced technology resulting from the implementation of the Project, may bring about the yields projected in the table below.

Class	Current Yield		Projected Yield	
	1st crop.	2nd crop.	1st crop.	2nd crop.
Class 1	4.5 t/ha	3.1 t/ha	6.0 t/ha	5.0 t/ha
Class 2	4.0	2.6	5.5	4.6
Class 3	2.5	1.6	5.5	4.6
Weighted average	3.9	2.6	5.7	4.8

The paddy field area based on the Land Use Plan is shown in Table 5.4.2. The table below sums up the measurement of the paddy fields in each class by alternative.

Class	Actual Area	Alternative A	Alternative B-1	Alternative B-2
Class 1	2,450 ha	2,500 ha	2,800 ha	2,510 ha
Class 2	3,080	3,050	3,400	3,400
Class 3	1,150	1,100	1,660	1,660
Total	6,680	6,650	7,860	7,570

The low cropping intensity at the actual situation is caused by inconsistent supply of irrigation water and poor land drainage, so improvement of these constraints will gradually increase the cropping ration and will realize double cropping to cover the whole development area of the paddy field starting 6th year and on after completion of irrigation/drainage system improvement works. As a consequence, an annual cropping area and production for respective alternative of "With" project situation are as shown below.

Alternative Plan	Without Project			With Project			Incremental Output (ton/year)
	Cultivated Area (ha/year)	Unit Yield (ton/ha)	Output (ton/year)	Cultivated Area (ha/year)	Unit Yield (ton/ha)	Output (ton/year)	
A	9,500	3.42	32,500	13,300	5.22	69,415	36,915
B-1				15,720	5.21	81,906	49,406
B-2				15,140	5.20	78,716	46,216

With project implementation, it is anticipated that the output of paddy will be increased by 214% for the Alternative Plan A, by 252% for the Alternative Plan B-1, and by 2.42% for the Alternative Plan B-2.

5.4.4 Upland Crops

(1) Outline of Cropping

Of existing paddy fields, some portion equivalent to 110 ha which are not irrigated by gravity will be converted into uplands, meanwhile uplands which may be benefited by gravity irrigation deem to be converted into paddy fields if another conditions permit it. As an outcome of these conversions, uplands within the development area will be reduced to 170 ha (Alternative Plan A) and to 110 ha (Alternative Plans B-1 and B-2).

Crops produced in said farmlands are important to the farm household economy in the area.

In the decrease of cropping area, uplands crop production plan is delineated in view of increasing output by mans of enhancement of cropping intensity as well as elevating unit yield owing to improvement of cropping technology. The plan also intends to increase vegetable and edible crop production in order to increase farmers' cash income, curtail daily expenses by inter-regional supply and improve farmers' diet.

(2) Production Plan for Vegetables and Edible Crops

The plan aims to establish a sustainable cropping system with the continuous cultivation of current main crops and the introduction of some new crops in consideration of social and natural environmental conditions. A rotation system will be established in order to prevent injuries that may result from the continuous cropping of solanaceous vegetables and haricot beans.

1) Cropping plan

A three year rotation system consisting of three patterns of double or triple cropping of annual crops is established. The fundamental cropping patterns are as follows (ratio of cropping area is shown by %);

Pattern I: cucumbers — solanaceous vegetables (sweet peppers 40%, tomatoes 40%, eggplants 20%)

Pattern II: leafy vegetables — leafy vegetables — pumpkins (leafy vegetables: Chinese kale, pak-choi, etc.)

Pattern III: haricot beans — maize

The area to be covered by each cropping pattern will be the same. On the other hand, sweet potatoes, cassavas, yautia and pigeon peas will still be cultivated continuously on the same field.

Besides organic compost, the application of chemical fertilizers is also recommendable. The amount of fertilizer (showing in N-P-K elements) to be applied according to crop is established as follows:

100-50-60 kg/ha for fruit vegetables, 70-50-60 kg/ha for leafy vegetables, 10-10-10 kg/ha for pulses, 20-20-30 kg/ha for tuber crops, and 50-30-30 kg/ha for maize respectively.

The cropping plan formulated based on the above-mentioned rule is shown in Fig. 5.4.2.

2) Target production

Reasonable cropping systems and new technologies resulting from the implementation of the Project may bring about an increase in crop yield. However, the cropping area will be declined in accordance with the land use plan which is focused on rice production.

Based on the above conditions, the target production volume was established and is shown in Table 5.4.3. The total production of vegetables in each of Alternatives will be maintained status quo or becomes more than the actual level, attaining an annual output of 1,494 tons for the Alternative Plan A and 996 tons for both Alternative Plans B-1 and B-2. The marketing of 500 to 1,000 tons of vegetable per year may be possible.

5.4.5 Livestock Farming Plan

The total area of pasture lands within the development area is 1,840 ha and some portion of these lands which will be benefited by improvement of irrigation and drainage systems are converted into paddy fields in compliance with alternative plans; with exception of some lots to be covered by reservoir and other infrastructures, the area of pasture lands "With" project will account for: 1,330 ha for the Alternative Plan A and 360 ha for the Alternative Plan B-2, while the Alternative Plan B-1 will comprise none of pasture lands. In decreased pasture lands proposal will be made to intensify animal husbandry by introduction of improved pasture together with advanced cattle raising technique.

It is important to provide the cattle herd with healthy grasses throughout the year and maintain the productivity of the pastures for a long period of time. Therefore, to maintain and improve vegetation, grazing will be carried out on a rotational basis and measures will be taken to control the proliferation of weeds.

5.4.6 Agricultural Output

Following above-cited cropping plans, the sum of agricultural output (from 6th year on after completion of construction works) consists of rice, uplands crops and livestock is calculated as given in the table below.

Unit: ton

Crops	Without Project	With Project					
		Altern. A	Balance	Altern. B-1	Balance	Altern. B-2	Balance
Paddy	32,500	69,415	36,915	81,906	49,406	78,716	46,216
Upland Crops	440	2,428	1,988	1,588	1,148	1,588	1,148
Sub-total	32,940	71,843	38,903	83,494	50,554	80,304	47,364
Beef[1/]	3,588	3,112	-476	0	-3,588	842	-2,746
Milk[2/]	4,581	3,970	-611	0	-4,581	1,080	-3,501

Note: 1/ - kiloliter, 2/ - head

And, in accordance with this output plan together with actual farm-gate price, an annual production value within the development area (from 6th year on after completion of the construction works) is obtained in the following manner.

Unit: RD$ x 1000/year

Crops	Without Project	With Project					
		Altern. A	Balance	Altern. B-1	Balance	Altern. B-2	Balance
Paddy	146,250	312,368	166,118	368,577	222,327	354,222	207,972
Upland Crops	1,642	9,307	7,665	5,955	4,313	5,955	4,313
Sub-total	147,892	321,675	173,783	374,532	226,640	360,177	212,285
Beef	12,464	10,811	-1,653	0	-12,464	2,925	-9,539
Milk	17,088	14,808	-2,280	0	-17,088	3,140	-13,948
Sub-total	29,552	25,619	-3,933	0	-29,552	6,065	-23,487
Total	177,444	347,294	169,850	374,532	197,088	366,242	188,798

The above estimation reveals that the increase of agricultural value "With" project will be in proportion with 196% (Alternative Plan A), 211% (Alternative Plan B-1) and 206% (Alternative Plan B-2) in comparison with "Without" project.

5.4.7 Farm Economy

The implementation of the present agricultural project will enable farmers in the development area to realize double cropping of paddy a year owing to consistent supply of irrigation water, improvement of drainage condition and mitigation of flood damage. As a consequence of this betterment, cropping intensity of paddy will be elevated from 142% to 200% a year, and unit yield of the same crop will attain higher level from 3.42 ton/ha to 5.20 ton/ha.

On the other hand, in so far as the production cost of paddy is concerned, the above-mentioned enhancement of productivity will be brought by external factors such as consistent supply of irrigation water and improvement of drainage condition, an increase in amount of inputs will not be accompanied except for harvesting; conversely, it is recognized that seed, fertilizer and agricultural chemicals are applied in excess of optimum amount, therefore reduction of application amount of these inputs is proposed in this cropping plan. Although rising of water charge (from RD$ 176/ha at the "Without" project situation to RD$ 394/ha at the "With" project situation - Alternative Plan A) is induced by improvement of irrigation system, this rise will not affect greatly profitability of paddy farming because the share of water charge within the global cost of production is extremely trivial (fewer than 1%). In sum, the proposed production cost of paddy will have a slight increase from RD$ 15,095 ("Without" project) to RD$ 15,720 ("With" project).

Taking above-mentioned discussion into account, the net return of paddy farming for both "Without" and "With" project situations with regard to average farmer is estimated in the following manner.

	"Without" Project	"With" Project
Paddy field (ha)	4.5	4.5
Cultivated area (ha/year)	6.4	9.0
Unit yield (ton/ha)	3.42	5.20
Production (ton/year)	21.9	46.8
Farm-gate price (RD$/ton)	4,500	4,500
Gross return (RD$/year)	98,550	210,600
Production cost (RD$/ha)	15,095	15,720
Production cost (RD$/year)	96,608	141,480
Net return (RD$/year)	1,942	55,170
Net return (RD$/ha)	303	6,130

5.5 AGRO-PRODUCTS MARKETING AND PROCESSING PLAN

5.5.1 Principal in Formulating the Plan

The agro-products marketing and processing plan shall be formulated for attaining the following objectives:

- To reconcile the interest of farmers by promoting their participation in marketing process and to strengthen farmers' organization endowing it with substantial function.
- To develop agro-industry within the area so as to generate more job opportunity and to create more job opportunity among local inhabitants.

This plan will have coordination with the agricultural production and farming system development plan. In addition, the following aspects shall be duly taken into account.

- Actual situation for marketing and processing of agro-products in the Study area, especially, constraints featured by the sector.
- Marketing circumstances not only at regional and national level but also at international level.
- Government policy on development of the marketing sector.
- Perspective for supply and demand of products in the future.
- Identification of beneficiaries of the plan.

5.5.2 Perspective of the Markets

With implementation of the present agricultural development project, the output of paddy will have a substantial increase in such rate as 200 % for the Alternative A, 235 % for the Alternative B-1, and 225 % for the Alternative B-2. Even the actual production

level, an integrated milling capacity of the existing installations is so deficient that about half of the harvests within the area processed at rice mills located outside the area. Furthermore, it is worth while to indicate that most of rice mills in the area are small-scaled and poorly equipped with machinery and facility that result in producing inferior quality of milled rice with higher proportion of broken rice.

In this moment, a ultramodern rice processing complex without equivalent type and scale in the country has completed is construction in the El Pozo area and will be put into operation soon. On the other part, under the pressure to open domestic market for foreign products and to reduce tariff on imported commodities, it is supposed that importation of rice will rise in the future. Under the circumstances, milled rice to be produced in the Study area are requested to be such high-quality as are competitive with those in adjacent areas as well as imported rice, and in this sense expansion and strengthening of existing rice milling installation are indispensable.

No marketing and processing plan will be touched with crops other than rice, because their production is small in output and will not be increased with implementation of the Project.

5.5.3 Formulation of the Development Plan

(1) General description of the plan

The agro-products marketing and processing plan contemplates to construct rice processing facilities equipped with innovated machinery within the Study area which permits to cope with proposed increase in paddy production and to produced improved quality of milled rice. The facilities will be administrated and operated by farmers' organization to comply with the objectives of this plan. At present, five organizations called "Cooperativa" which aim at performing cooperatism and one organization called "Federacion" have been formed without conducting any substantial activity up to date. Thus these six organizations shall be proposed executing agency of rice milling facilities.

(2) Outline of the facilities

The scale of the rice milling facilities shall approximate the existing facility of FALY located at Guaraguao area. Each facility shall have the following outline:

Lot area

- Total area: 630 m^2
- Area for storage, drying and milling: 450 m^2
- Office: 100 m^2

Equipment and machinery

- Milling machine: 3 ton/hr (milled rice)
- Drying equipment: 100 ton/day
- Generator
- Other equipment such as hopper, moisture gauge, etc.

Vehicles and office equipment
- Truck, pick-up, motor bike
- Set of office equipment and furniture

(3) Balance for operation of rice milling facilities

It is estimated that construction cost for one rice milling facilities to be approximately RD$ 10,000,000. Provided that an average operation rate of rice milling facilities is 50% , the following annual gross income will be anticipated:

3 ton/hr. x 8 hr. x 20 days x 0.5 x 12 months x RD$ 8,700/ton
= RD$ 25,056,000

And, an annual net profit of RD$ 1,253,000 is to be expected subject to setting the rate of return to be 5%.

(4) Location and beneficiaries of the facilities

The facilities will be installed at Baraquito, La Reforma, Los Peinadores, Paraguay and La Pista where five cooperatives are located, and at La Ceiba de los Pajaros one federation is located. Direct beneficiaries of the facilities shall be 625 families in total which are affiliated member of the said six rural organizations.

5.5.4 Justification and Suggestions on Implementation of the Development Plan

The construction of the six rice milling facilities will enable to produce approximately 3,600 tons of milled rice (3 tons/hr. x 8 hrs x 25 days x 6 facilities) a month, which is equivalent to processing 6,000 tons of paddy a month. It is anticipated that the implementation of Limon del Yuna Area Agricultural Development Project will increase paddy output by nearly 20,000 tons per harvest season and the construction of six rice milling facilities will contributes to absorbing one-third of the increased output.

Apart from the above-mentioned contribution, the development of rice milling facilities is expected to promote prosperity of agro-industry within the Study area and to generate job opportunity for local population. In addition, administration and operation of the facilities by farmers' organization will activate these organizations which are actually at a standstill of function and will elevate cooperatism among their affiliated members. It is advised that rice milling facilities will expand their activities in such fields as sale of agricultural inputs and , rental of agricultural machinery, provision of credit, and once realized this expansion, farmers participated in organizations will benefited greatly. In sum, the development of rice milling facilities is justified from the viewpoint of strengthening rural organization, needless to say its direct benefit to process increased paddy.

Judging from above-mentioned explanation, it is considered that the development of rice milling facilities is justifiable. Nevertheless taking account that this kind of agro-industry development is generally alienated from public works development projects to be undertaken by INDRHI, it is suggested that the construction of rice milling facilities

should be implemented by private sector, apart from the development of the present project. Because the development of agro-industry is closely related with the development of the Limon del Yuna Agricultural Development Project, the following institutional services to be rendered by governmental organizations are prerequisite for effective implementation of the plan.

- Financial arrangement for construction of facilities and operation of initial capital.
- Technical advise on proper operation of the facilities and production of improved milled rice.
- Educational campaign and training to strengthen farmers' organization.

5.6 IRRIGATION AND DRAINAGE PLAN

5.6.1 Water Intake Plan

As explained in 4.2.2 - Development Potentials of the Water Resources, the following water resources can be used as sources of irrigation water.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Wetern Sector	3.000	2.498	2.163	2.150	3.260	4.962	4.572	4.871	4.837	4.611	4.366	3.692
- Payabo River	1.600	1.370	1.130	1.050	1.610	2.650	2.570	2.810	3.050	3.010	2.570	1.970
- Cano Ponton	0.636	0.513	0.470	0.500	0.750	1.051	0.910	0.937	0.812	0.728	0.816	0.783
- Cevicos River	0.764	0.615	0.563	0.600	0.900	1.261	1.092	1.124	0.975	0.873	0.980	0.939
2. Easter Sector	5.058	4.074	3.731	3.972	5.963	8.351	7.235	7.442	6.457	5.783	6.487	6.218
- Guaraguao	1.776	1.430	1.310	1.395	2.094	2.932	2.540	2.613	2.267	2.031	2.278	2.183
- La Cueva	0.519	0.418	0.383	0.407	0.611	0.856	0.742	0.763	0.662	0.593	0.665	0.638
- Lagnita Cristal	1.341	1.080	0.989	1.053	1.581	2.214	1.918	1.973	1.712	1.533	1.720	1.648
- Laguna Cristal	0.584	0.471	0.431	0.459	0.689	0.965	0.836	0.860	0.746	0.668	0.749	0.718
- El Cercado	0.838	0.675	0.618	0.658	0.988	1.384	1.199	1.233	1.070	0.958	1.075	1.031

In addition, the following water resources may be taken to use for irrigation purpose.

1. Reservoir: About 800 ha of land will be irrigated with the maximum storage volume of 4 million m^3
2. Yuna River: A maximum of 2 m^3/s of water is available
3. Return flow: Reuse of discharged water into drainage canals

The total amount of available water to be taken form the above sources is not abundant on average, so the irrigation planning will be formulated taken the whole resources cited above into account.

5.6.2 Irrigation Plan

(1) Crop water requirements

1) Meteorological data

The meteorological data used for irrigation planning are those recorded at the Barraquito station, where liable meteorological data such as temperature, humidity, wind velocity, amount of cloud are compiled. Data collected for the period 1975-92 were processed for this purpose.

2) Cropping calendar

The cropping calendar proposed in the "Agricultural Production and Farming System Plan" is as follows:

Farming Work	1st Cropping	2nd Cropping
Seeding on nursery bed	Early Dec. - Mid Jan	Early Jun - Mid Jul
Farming Works	Early Jan - Mid Feb	Early Jul - Mid Aug
Harvesting	Early May - End Jun	End Oct - Mid Dec

3) Unit water requirement

The unit water requirement is calculated using the following formula:

$$UWR = \{Eto \times kc + WRLP + DP - ER\} \times IR$$

where: Eto = reference crop evapotranspiration
kc = crop coefficient
WRLP = water requirement L.P. (100 mm/day)
DP = deep percolation (1.0 mm/day)
ER = effective rainfall
IR = irrigation efficiency (0.58)

The peak unit water requirement falls on April, while less water is required for three months from November to January.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Unit Water Requirement	0.402	0.746	0.942	1.061	0.743	0.420	0.512	0.953	0.908	0.688	0.311	0.244

(2) Irrigation network

1) Basic concept on planning canal system

a. Minimum block

The minimum block for convenience of operation and maintenance of irrigation water is established as around 40 ha (400 m x 1,000 m). This

block corresponds to the tertiary unit, in which the "Nucleos de Regantes" formed by 10 or so water users will take charge of operation and maintenance of related gate.

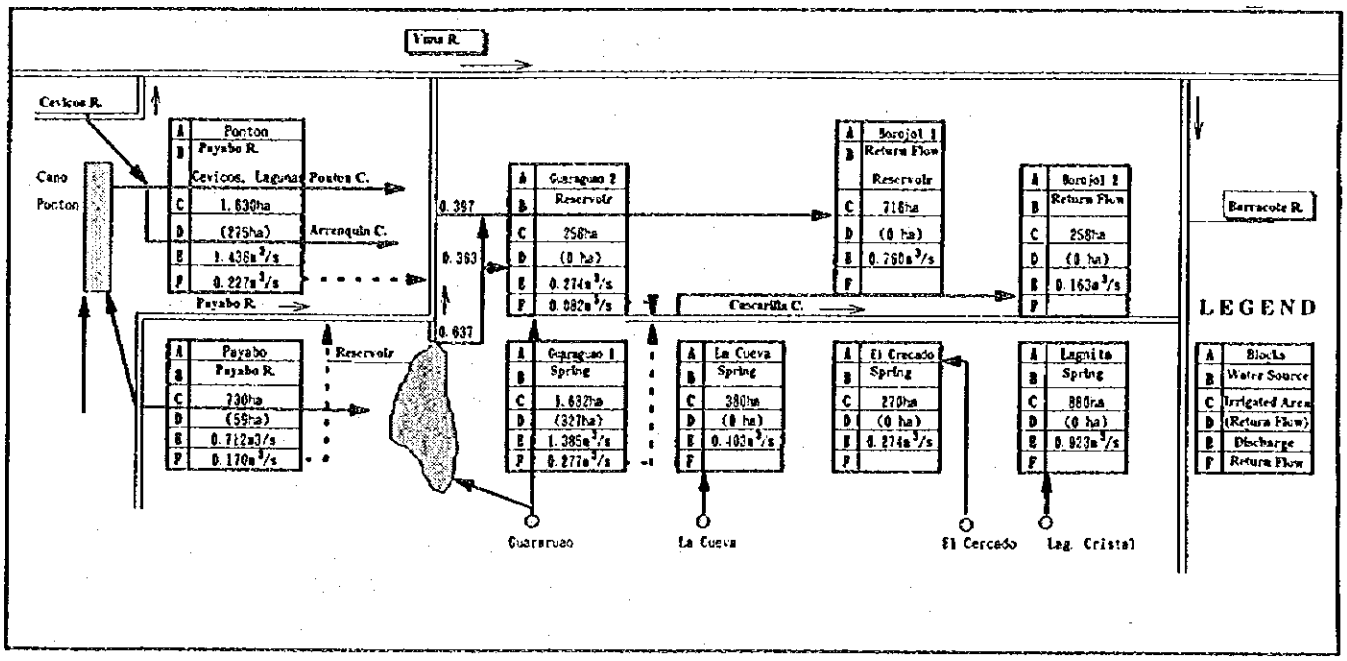
b. Canal system for operation and maintenance (O/M)

Irrigation water is to be distributed to paddy fields in the order of: main canals, secondary canal and tertiary canals, thus irrigation system to deviate water directly from main canals or secondary canals to paddy fields is avoided. Diversion works equipped with water gate which regulates distribution of water will be installed at the crossing part of canals so that the minimum unit of the water users' association (Junta de Regantes) might be in charge of the tertiary gates.

2) Irrigation block

Taking into consideration of the actual irrigation network as well as available water resources, the irrigation network for the project is proposed as illustrated in Fig. 5.6.1 and Fig. 5.6.2. This proposed irrigation network is summarized in the table below.

2-1) Alternative Plan A



Irrigation System (Alternative A)

Irrigable Blocks	Source of Water	Irrigable Area (ha)		Intake Volume (m3/s)	Available Return flow (m3/s)
		Total	Return Flow		
Payabo	Payabo River	730	59	0.712	0.170
Ponton	Payabo River Cevicos River Springs	1630	275	1.438	0.227
Guaraguao-1	Springs	1632	327	1.385	0.227
Guaraguao-2	Reservoir	258	-	0.274	0.082
La Cueva	Springs	380	-	0.403	
El Cercado	Springs	270	-	0.286	
Lagnita Cristal	Springs	880	-	0.934	
Borojol	Return flow Reservoir	870	870	-	0.923
Total		6650	1531	5.432	1.629

a. Payabo block

A headworks will be installed at the Payabo river to take 1.05 m^3/s of water; of which 0.719 m^3/s will be distributed to the Payabo block and the remaining 0.331 m^3/s will de deviated to the Ponton block. Irrigation water through the main canal will flow to the east along the Los Haitises to benefit 730 ha of paddy fields located up to the confluence with the Guaraguao canal. Drained water from this block can be used to irrigate the Borojol block.

b. Ponton block

Irrigation water to this block will be taken from the Payabo river (0.331 m^3/s), the Cevicos river (0.60 m^3/s), and springs (0.50 m^3/s). Some paddy fields (82 ha) situated at higher land elevation will be irrigated by pumping to comply with their actual situation. Water taken from the Caño Ponton will be regulated by the gate to be installed at the intake point of the Ponton Canal. Irrigation water to flow this Ponton Canal will be diverted to the Arrenquin Canal at 2.5 km downstream from the start of the Ponton Canal. Drained water from this block will irrigate the Borojol block.

Some sections within this block are unable to be irrigated by gravity, which enforces to employ pumping system. These sections are:

Section A: 51 ha (0.054 m^3/s)
Section B: 127 ha (0.135 m^3/s)

c. Guaraguao block-1

The Guaraguao Spring offers the most abundant water resource within the Study area, so irrigable area by this spring can be extended

to the paddy fields near the Yuna river, which are located to the opposite side of the spring. The main canal will be placed along the river bank which constitutes the western limit of the Study area.

d. Guaraguao block-2

Although the Guaraguao has an abundant available water to irrigate 1,890 ha of paddy fields, some of these paddy fields are not benefited by water of the spring in March and April if they are planted paddy twice a year. For breaking this bottleneck, it is proposed to construct a reservoir and to arrange the existing irrigation block.

To irrigate 600 ha of paddy fields consist of 258 ha in the Guaraguao block and 342 ha in the Borojol block, a total of 290 million m^3 of water (110 m^3 for the Guaraguao block and 180 m^3 for the Borojol block) should be stored at the reservoir, and to attain this storage the effective minimum and the maximum water levels of the reservoir are designed to be each 9 m.a.s.l. and 12 m.a.s.l. Irrigation water will be supplied from the reservoir through the canal designed exclusively for this system.

e. La Cueva block and El Cercado block

Spring water taken from La Cueva and El Cercado will be used to compensate shortage of irrigation water at the Guaraguao block-1. Due to lower water level, water of the El Cercado Spring has not been used for irrigation purpose up to date; in this irrigation planning it is proposed to distribute this water to the paddy fields located to lands with lower elevation.

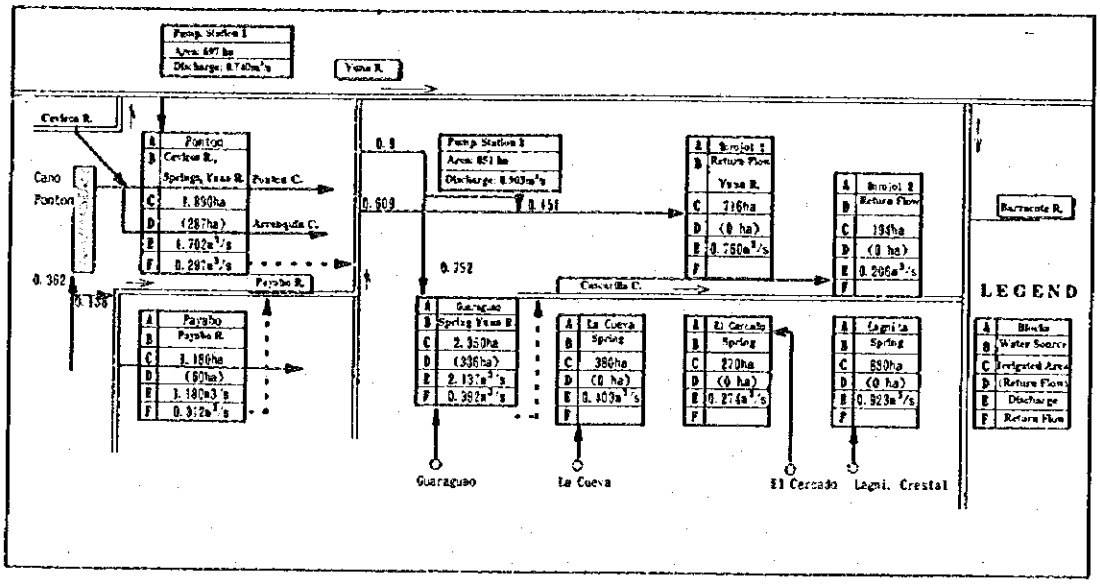
f. Lagunita Cristal block

This block corresponds to the irrigable area from the Lagunita Cristal. Lagunita Cristal has such sufficient water resource as to benefit irrigable area of this block without relying on other sources, so this block will be the same as the actual situation.

g. Borojol block

For rational use of irrigation water, this block is divided into two sub-blocks; one is a sub-block which is to be benefited by taking drained water from the Payabo and Ponton blocks by means of the headworks to be installed at the Payabo river and complementing is with water distributed from the reservoir and the other sub-block will be irrigated by return water discharged in the Cascarilla Canal. The main canal will be placed along the Yuna river.

2-2) Alternative Plan B



Irrigation System (Alternative B)

Irrigation Blocks	Source of Water	Irrigable Area (ha)		Intake Volume (m3/s)	Available Return flow (m3/s)
		Total	Return Flow		
Payabo	Payabo River Springs	1180	60	1.188	0.064
Ponton	Yuna River Cevicos River	1890	287	1.702	0.304
Guaraguao	Springs Yuna River	2350	336	2.137	0.356
La Cueva	Springs	380	-	0.403	
El Cercado	Springs	270	-	0.286	
Lagnita Cristal	Springs	880	-	0.934	
Borojol	Return flow Yuna River	910	768	-	0.966
Total		7860	1451	6.650	1.690

The Alternative Plan envisages the following aspects which are different from the alternative A.

a. Intake of water from the Yuna river by means of pumping system is considered. Irrigable area and intake volume proposed for this pumping system are:

Blocks	Irrigable Area (ha)	Intake Volume (m^3/s)
Ponton	697	0.740
Guaraguao	709	0.752
Borojol	142	0.151
Total	1,548	1.643

b. Construction of a reservoir is not included; this alternative pretends to cover proposed land for this infrastructure into paddy field (approximately 100 ha).

c. Diversion of spring water flowing into Caño Ponton to the Payabo block is proposed.

5.6.3 Drainage Plan

The great majority of excess water within the Study area is drained into the Payabo river and the Cascarilla Canal. These two systems function as a main drainage canal which connects with the remainder of the drainage systems within the Study area. Improvement proposal on the Payabo river and the Cascarilla Canal will be discussed in the "Flood Mitigation Plan".

The submergence analysis quoted in the section 3.11.2 (2) of this report has disclosed that even intensive rainfall is taken place no serious damage would be brought about over agricultural production due to flooding of paddy fields. This means that flooding caused by intensive rainfall is within limit of allowable submergence. Nevertheless, in view of the fact that some drainage systems pass through populated area, the drainage canals will be designed with a cross-section which enables to drain 24-hour-rainfall within 24 hours under 5-year-return period.

(1) Drainage network

The principle of drainage planning is to drain excess water to the main drainage canal after passing through small and secondary drainage canals. The existing main drainage system which connect with the Payabo river and the Cascarilla canal will be improved to function adequately as secondary canal system and, to complete the drainage network throughout the development area, small drainage system will be jointed with these secondary system. On the other hand, a drainage system which makes it possible to function drainage of excess water constantly will be provided at poor drainage lands located at the foot of the Los Haitises National Park.

(2) Canal section

The design runoff is predicted according with the following formula:

$$Q = f \times R \times A/3.6$$

where, Q = design runoff (m^3/s)
f = runoff coefficient (0.75)
R = average rainfall intensity (5.57 mm/hr., 133.7 mm/day)
A = catchment area (km^2)

The catchment area of the secondary drainage canal system is estimated to be around 6 km^2, so the relation between the catchment area and the design runoff becomes as shown below.

Catchment area (km^2)	1	2	3	4	5	6
Design runoff (m^3/s)	1.2	2.3	3.5	4.6	5.8	7.0

5.7 FLOOD MITIGATION PLAN

Flooding within the Study area is caused by backwater stemmed from flooding of the Yuna river and the Barracote river as well as by overflow of the Payabo river. The flood mitigation plan is formulated on the basis of the analysis on actual performance of backwater.

For controlling overflow of the Payabo river, it is necessary to take two measures: (1) to regulate backwater coming from the Yuna river and (2) to alleviate flood at the head of the stream of the Payabo river, meanwhile flooding of the Cascarilla canal should be mitigated by taking action against backwater of the Barracote river. The flood mitigation plan in this development study is delineated subject to the following allowable submergence.

Allowable submergence: Submergence deeper than 30 cm should take place within 24 hours provided that this depth should not exceed 80 cm taking the height of paddy plant

5.7.1 Measures to Control Backwater of the Yuna River

Backwater of the Yuna river may be controlled by means of either: (1) to install water gate at the confluence of the Yuna river with Payabo river to cut off return flow or (2) to elevate embankment of the Payabo river higher than the flood water level. In the present plan, the latter is adopted supported by the following technical justifications.

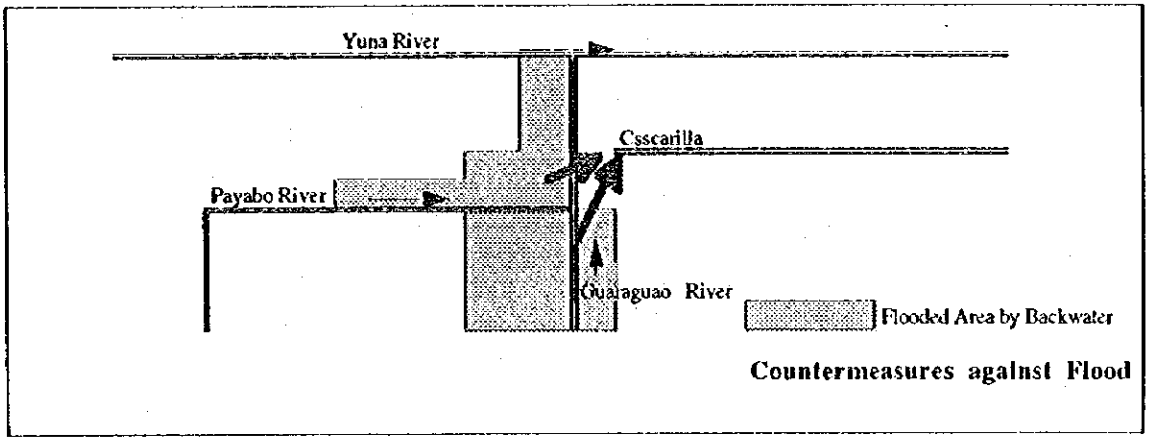
a. Within the context of flood mitigation plan to cover the whole basin of the Payabo river, it is indispensable to elevate embankment in view of upgrading flowing capacity of the river; the former measures requires additional cost for installation of water gate.

b. The operation of water gate in time of flooding demands sophisticated technique which evokes anxiety in its operation and maintenance.

The elevation of embankment will lead to strengthen flowing capacity of the Payabo river in the following manner.

Distance from the Confluence with Yuna (km)	Actual Capacity (m^3/s)	Enhanced Capacity (m^3/s)
0.0 - 4.5	80	100
4.5 - 7.5	60	80
7.5 - 18.5	40	60

With elevation of embankment overflow of river water can be prevented, but this measure will result in increasing river water level, which will make it impossible to discharge excess water of paddy fields situated both margins of the river. For solving this problem proposal will be made to divert surface water of the paddy fields cited above to the Cascarilla canal. The connection of the Payabo river with the Cascarilla canal will be made at two sections as illustrated below. Detailed design condition will be established in accordance with flood analysis data of the Payabo river.



Structures required for the above proposal are as mentioned hereinafter.

a. A siphon (box culvert type) will be installed crossing the Payabo river from the left margin to the right margin.

b. An access canal to divert flow of the Guaraguao river to the Cascarilla canal will be placed with installation of roller gate with flap to cut off return flow at the confluence of the Guaraguao river with the Cascarilla canal. This canal shall be a spillway type to comply with diversion function mentioned before.

5.7.2 Measures to Mitigate Flooding at Upper Stream of the Payabo River

The analysis on prevailing flooding implies that the frequency of flooding to surpass allowable submergence and period is very low. This suggests that with small expansion of the actual river section paddy fields will be kept within allowable submergence depth. Study on viability to construct flood mitigation dam at upper basin of the Study area will be carried out at the same time.

(1) Diversion flow to the Cascarilla canal

Judging from the flowing capacity of the Cascarilla canal, the flooding volume which may be diverted from the Payabo river to the Cascarilla canal will be 30 m^3/s in total, which is consists of:

10 m^3/s : through the siphon to across the Payabo river, and
20 m^3/s: through the access canal to distribute flow of the Guaraguao river to the Cascarilla canal

(2) Expansion of the section for diversion canals

The flooding discharge can be diverted to the Payabo river as well as to the Cevicos river and the flowing capacity of these two systems is estimated with regard to the nine cases of submergence depth. The result of this estimation is summarized in the table below.

Case	Diverted Destination	Flowing Capacity (m^3/s)[1/]	Submergence Depth (m)/hour[2/] A[3/]	B[4/]
1	Payabo	20		
	Ponton	20	0.94/12.0	0.74/20.5
2	Payabo	20		
	Ponton	40	0.93/11.5	0.72/19.0
3	Payabo	20		
	Ponton	60	0.90/10.5	0.70/17.0
4	Payabo	40		
	Ponton	20	0.96/13.5	0.73/19.0
5	Payabo	40		
	Ponton	40	0.93/12.5	0.71/17.0
6	Payabo	40		
	Ponton	60	0.90/11.5	0.69/15.5
7	Payabo	60		
	Ponton	20	0.94/14.5	0.69/15.0
8	Payabo	60		
	Ponton	40	0.91/13.0	0.69/15.5
9	Payabo	60		
	Ponton	60	0.90/12.0	0.67/14.5

Note: 1/ Based on the section of the upper reach for the Payabo river and on the diversion canal for the Caño Ponton
2/ Deeper than 30 cm
3/ Lands with deepest submergence
4/ Land with the second deepest submergence

The deepest submergence is identified with the lands at the lower reach of the Guaraguao river, which is followed by the lands at the point where flood originated from the Los Haitises National Park inflows the Study area; reasons for deeper submergence are explained by the lower elevation of lands (used as grazing land) for the former and by the increasing discharge just in front of the diversion point. The former lands are suffered from consistent inundation deeper than 80 cm and for this fact they will not be developed as paddy fields in the Alternative A (soil dressing works with a thickness of 20 cm or so is necessary to develop these lands for paddy field). Because expected benefits to be produced by upgrading flowing capacity will be insignificant, an improvement of the flowing capacity up to the case 1 shall be sufficient.

(3) Flood mitigation dam

The relation between dimension of structure and expected effect for the construction of dam was studied subject to the following three premises.

a. Flowing capacity of the Payabo river: 10 m^3/s

Elevation of embankment will contribute to raise this capacity from 5 m^3/s of the actual capacity to 10 m^3/s.

b. Capacity of diversion canal of Ponton: 20 m^3/s

This canal will function as spillway of the Caño Ponton, so this capacity will be required.

c. Design criteria

- Return period: 1/20
- Spillway : Return period of 1/100 (Design discharge = 546 m^3/s)
- Submergence analysis on the benefitable area shall be made with return period of 1/5

	Case 1	Case 2	Case 3
1. Design discharge (m^3/s)	42.8	96.7	194.9
2. Decreasing ratio of peak discharge (%)	85.6	67.5	34.4
3. Maximum allowable submergence (m)	0.27	0.52	0.71
4. Submergence time deeper than 30 cm (hr.)	0	47.0	17.0
5. Maximum water level (m)			
- Return period: 1/5	21.84	20.72	19.04
- Return period: 1/20	22.97	22.19	20.42
6. Overflow depth of spillway (m)	1.4	1.4	1.4
7. Free board (m)	1.6	1.6	1.6
8. Extra banking (m)	0.3	0.3	0.3
9. Height of the crest of dam (m)	26.27	25.49	23.72
10. Dam height (m)	14.77	13.99	12.22
11. Embankment volume (m^3)	310,186	278,215	209,308
12. Concrete volume (m^3)	18,680	18,680	18,680
13. Cost of construction works (RD$ x 1000)	199,200	184,500	152,900

As shown in the table above, the construction of a dam aiming at mitigating flooding damage will have remarkable effect; with decrease of peak discharge by 34% the maximum allowable submergence can be elevated to 0.71 cm and with decrease by 85% no land covering the whole development area will be inundated deeper than 30 cm. The definite constrain on development of this proposal is extremely elevated construction cost against tangible benefit of it, which leads to the conclusion that the construction of a flood mitigation dam is not economically feasible.

(4) Selection of the optimum flood mitigation measure

Proposed amount of soils to be excavated shall be 400,000 m^3 in case that the flood mitigation plan contemplates only river improvement works and 200,000 m^3 if dam construction is included in the said plan; this balance in soils excavation amount is estimated to be approximately RD$ 9,000,000 if converted into construction cost and is meaningless in comparison with the construction cost of dam.

The discussion conducted herein together with analysis made in previous sub-sections 5.7.2 (1) through (3) leads to the conclusion that the optimum plan to mitigate flooding damages shall be to expand section of the Payabo river in such dimension as to attain the flowing capacity of 20 m^3/s and to divert flow discharge from the Caño Ponton to the Cevicos river at the rate of 20 m^3/s.

The construction of a dam, which promises higher benefits, will not be justified within context of paddy fields development project.

5.7.3 Measures against Backwater Flowing into the Cascarilla Canal

The flood water level of the Cascarilla canal is 2.75 m under the return period of 1/5, so damages on agricultural production caused by inundation may be evaded if paddy is not planted at lands lower than 2 m.a.s.l. in view of the fact that the maximum submergence depth is 0.75 m. It is recommended to install roller gate with flap at the connection of the canal with drainage canal so that return flow from the canal into paddy fields should not be taken place.

5.8 RURAL INFRASTRUCTURES DEVELOPMENT PLAN

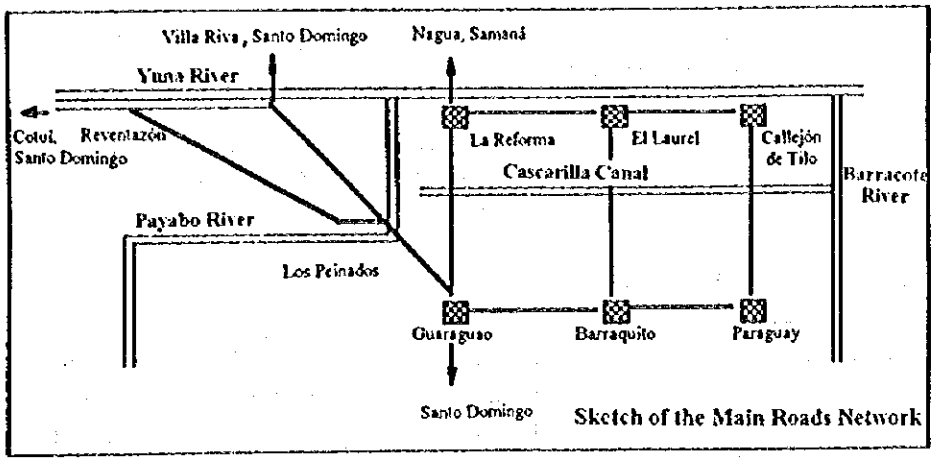
5.8.1 Road Plan

Proposal for improvement of road networks is shown in Fig. 5.8.1.

(1) Functions of road system

1) Main roads

Main roads serve as 1) an access among major villages within the Study area and connecting the Study area with other areas of the country. The rough sketch of the improved road network is as illustrated below



Sketch of the Main Roads Network

The existing main roads network will be intensified improving the following two roads which are not functioning as this category of road. The rest of routes shall remain untouched.

- Los Peinados - Reventazon	6.5 km
- Paraguay - Callejon de Tilo	3.5 km

2) Secondary and in-farm roads

Secondary and in-farm roads will be used as:

- Operation and maintenance of irrigation canals;
- Shipping of agricultural and livestock products;
- Access of agricultural machinery into farms;
- Communication among villages

In-farm road shall be traced at paddy fields in which land preparation has not been completed; paddy fields which are attained land preparation have in-farm roads, so no road development plan is contemplated in these paddy fields.

(2) Road structure

1) Road width

For the convenience of designing road width, reference is made to the passage of a combine. The main roads are required to be wide enough to permit the passage of combine by another vehicle. General specifications of a combine are represented by: 6.0 m of the overall machine width and 3.6 m of wheel width, so width of roads are proposed as given below.

Trunk road:	Road way	6m	Total width	8m
Lateral and in-farm road:	Road way	4m	Total width	6m

These widths are almost the same as those of the existing roads.

2) Road construction materials

Necessary materials to construct roads are available at borrow pit located near the Los Haitises National Park. In this road planning finishing materials such as asphalt and concrete are not included.

5.8.2 Other Rural Infrastructures

This plan does not assume to develop water and electric supply systems which are not directly related with agricultural development. Nevertheless, devices for washing cloths and other uses will be given in irrigation canals, reservoirs, springs, etc. which will keep constant water level so that local inhabitants may be uses these devices.

5.9 FACILITIES PLAN

Facilities Plan deals with infrastructures necessary for development of:

1) Irrigation system;
2) Drainage improvement;
3) Flood Mitigation measures;
4) Road network;
5) Land preparation; and
6) Project office.

5.9.1 Irrigation System

(1) Intake facilities

1) Reservoir

The reservoir is proposed at lower reach of the Guaraguao river and water taken from this structure is distributed to the Guaraguao and Borojol irrigation blocks. For construction of this structure, approximately 140 ha of land which are actually used extensively as rough grazing lands will be sacrificed. The design flood stage discharge to this reservoir is so small that 1 m of free board above the maximum surface level will be enough. The height of levee is designed to be in the range of 1 - 4 meter with exception for some portion which will have a 6-meter-height. Almost half of lands surrounding the proposed lot for the reservoir have elevation higher than 13 m.a.s.l., no additional embankment works is required for these lands. Specifications for the design of reservoir are as proposed below.

- Elevation of the lowest bowl of reservoir: 7.0 m.a.s.l.
- Elevation of crest: 13.0 m.a.s.l.
- Depth of reservoir : 6.0 m
- Maximum surface water level: 12.0 m.a.s.l.
- Minimum intake water level: 9.0 m.a.s.l

- Effective water depth: 3.0 m
- Effective water storage volume: 2,900,000 m^3
- Embankment volume: 54,000 m^3
- Related works: inflow works, intake works, spillway

2) Springs

a. Improvement of levees

The levees around proposed springs from which water for irrigation purpose is to be taken will be reinforced with additional embankment (4-meter-width of crest). Specifications for respective spring are as follows.

Springs	Elevation of the top of levee(masl) (1)=(2)+(3)+(4)	Design water level (masl) (2)	Overflow depth of spillway (masl) (3)	Free-board (masl) (4)
Ponton	17.4	15.8	0.8	0.8
Guaraguao	14.1	13.5	-	0.6
La Cueva	9.6	9.0	-	0.6
El Cercado	6.1	5.5	-	0.6
Lagunita Cristal	7.6	7.0	-	0.6

b. Replacement or construction of intake works

Replacement or construction of intake works is contemplated at the following springs.

- Ponton: 2 (Construction)
- Guaraguao: 2 (Replacement)
- La Cueva: 1 (Construction)
- El Cercado: 1 (Construction)
- Lagunita Cristal: 2 (Replacement)

c. Construction of spillway (Caño Ponton)

This spillway will be constructed at the confluence of the final reach of the Guaraguao river with the Cevicos river in view of preventing useless discharge from that point. This spillway will have the following structure and specifications which will permit smooth discharge of water flow.

- Structure: Steel and reinforced concrete
- Design discharge: 2 0 m^3/s
- Overflow width: 15.0 m
- Overflow depth: 0.76 m
- Elevation of the crest of overflow: 16.0 m.a.s.l.

3) Diversion weir

a. Payabo River (2 sites)

The diversion weir No.1 will be placed at 200 m upper reach of the site from where water is actually taken by gravity.

- Structure of weir: Fixed type
- Design intake volume: 1.185 m^3/s
- Design intake water level: 16.5 m.a.s.l.
- Height of weir: 2.5 m
- Width of fixed weir: 8.0 m
- Related works: intake with gate

The diversion weir No. 2 will be constructed at the confluence of the Payabo river with lower reach of the Guaraguao river to take return flow from the Payabo and Ponton irrigation blocks for diverting into the Borojol irrigation block.

- Structure of weir: Fixed type
- Design intake volume: 0.607 m^3/s
- Design intake water level: 7.5 m.a.s.l.
- Height of weir: 3.5 m
- Width of fixed weir: 14.0 m
- Related works: intake with gate

b. Cascarilla Canal

The diversion weir to be installed at this canal will be used to divert return flow coming from the Guaraguao irrigation block to the Borojol irrigation block.

- Structure of weir: Fixed type
- Design intake volume: 0.250 m^3/s
- Design intake water level: 4.7 m.a.s.l.
- Height of weir: 3.0 m
- Width of fixed weir: 35.0 m
- Related works: intake with gate

c. Cevicos river

The diversion weir proposed at this river shall have objective to divert river flow to the Caño Ponton throughout diversion canal with a length of 2 km. This weir shall have the following specifications.

- Structure of weir: Movable type
- Design intake volume: 0.600 m^3/s
- Design intake water level: 16.2 m.a.s.l (water level of Caño Ponton: 15.8 m.a.s.l.)

- Gate dimension: 3.0 height and 3.0 m width (2 gates).
- Width of weir: 14.0 m
- Related works: intake with gate, diversion canal

d. Pumping station

The pumping station is proposed to take river water of the Yuna or to make rational use of discharged drainage for the purpose of irrigating paddy fields to which conduction of water by gravity is technically unfeasible.

Pumping Station	Irrigation Block	Source of Irrigation Water	Design Intake Volume(m^3/s)	Actual Pump Head (m)	Remarks
PS-No. 1	Ponton	Yuna	0.740	9 m	Alternatives B-1&B-2
PS-No.2	Guaraguao Borojol	Yuna	0.903	8 m	ditto
PS-No.3	Ponton	Return Flow	0.135	3 m	All Alternatives
PS-No.4	Ponton	Return Flow	0.054	3 m	ditto
PS-No.5	Ponton	Return Flow	0.133	3 m	ditto

(2) Irrigation canals

1) Main canals

Main canals serves to distribute water from intake point to irrigation block; some canals will be rehabilitated and others will be constructed. Concrete lining will be made so as to avoid seepage during distribution.

2) Secondary canals

Secondary canals have a function to join main canals with tertiary canals; development of these canals will be either rehabilitation of the existing canals or construction new ones. Like main canals concrete lining to avoid seepage is proposed.

3) Tertiary canals

Tertiary canals are to be used to conduct irrigation water from main or secondary canals to paddy fields. Some canals will be rehabilitated and others will be newly constructed. Structure of these canals will be earth type.

4) Canal network intensity

Canal network intensity for respective irrigation block is as summarized in the table below.

Plan	Canal System	Payabo	Ponton	Guara-guao	La Cueva	Cercado	Cristal	Borojol	Average
A	Main	12.3	18.0	13.0	15.2	16.0	4.0	23.0	14.5
	Secondary	13.0	15.6	10.6	7.2	8.8	7.7	2.5	10.4
	Tertiary	30.8	34.5	31.5	35.6	31.8	34.9	29.9	32.7
	Total	56.1	68.1	55.1	58.0	56.6	46.6	55.4	57.5
B-1	Main	9.4	16.5	11.2	10.7	16.0	4.0	24.3	13.0
	Secondary	8.3	15.5	8.2	6.6	8.8	7.7	0.4	9.0
	Tertiary	32.5	34.6	31.8	36.7	31.8	34.9	31.7	33.2
	Total	50.2	66.6	51.2	53.9	56.6	46.6	56.4	55.2
B-2	Main	9.4	18.5	11.2	10.7	16.0	4.0	24.3	9.4
	Secondary	8.3	16.5	8.2	6.6	8.8	7.7	0.4	5.4
	Tertiary	32.5	36.0	31.8	36.7	31.8	34.9	31.7	25.8
	Total	50.2	71.0	51.2	53.9	56.6	46.6	56.4	55.8

5) Diversion works

Diversion works equipped with gate are to be places at critical points of main and secondary canals (mainly at diversion points). These diversion works are designed in three types, all of which are will be newly installed.

6) Road intersection works

These structures are proposed where canals intersect roads and shall be made of concrete pipe; they will be placed with soils cover of 1 m equipped with connection devices.

7) River intersection works (siphon)

These structures will be placed at the points in which canals intersect rivers and shall have structure of concrete lining over concrete pipe; placement shall be made with soils cover of 1.5 m.

8) Intake of return flow

This type of works will be installed at various sites of the development area to collect excess water discharged into drainage canals.

5.9.2 Drainage System

The drainage system shall be developed with an aye to solving poor drainage of paddy fields to enhance their productivity. Major drainage works contemplated in this plan are as featured hereinafter.

(1) Drainage canal

1) Main and secondary canals

Reviewing on the basis of design drainage discharge the drainage network will be intensified either by rehabilitation of existing canals or by constructing new canals. Structure of canals shall be unlined.

2) Tertiary canals

Tertiary canals derived from main or secondary canals shall be improved without lining. Canal depth is designed to be 0.7 meter lower than elevation of paddy fields taking subsurface drainage into account.

3) Canal network intensity

Drainage canal network intensity for respective irrigation block is as summarized in the table below.

Plan	Canal System	Payabo	Ponton	Guara-guao	La Cueva	Cercado	Cristal	Borojol	Average
A	Main	2.5	4.4	-	-	-	-	-	1.3
	Secondary	19.2	17.2	5.1	8.1	9.3	9.3	7.5	10.8
	Tertiary	35.7	28.7	22.4	37.9	27.1	30.3	29.9	27.2
	Total	57.4	50.2	27.5	46.1	36.3	39.6	27.4	39.4
B-1	Main	1.5	4.4	-	-	-	-	-	1.3
	Secondary	14.7	15.9	4.5	13.2	6.1	9.3	6.5	10.0
	Tertiary	33.3	27.4	24.2	35.2	23.9	30.3	23.1	27.4
	Total	49.5	47.7	28.7	48.4	30.1	39.6	29.6	38.7
B-2	Main	1.5	4.0	-	-	-	-	-	1.1
	Secondary	14.7	16.9	4.5	13.2	6.1	9.3	6.5	10.1
	Tertiary	33.3	28.0	24.2	35.2	23.9	30.3	23.1	27.6
	Total	49.5	48.9	28.7	48.4	30.1	39.6	29.6	38.7

(2) Drainage gate

This structure shall be installed at main drainage canal of the Ponton irrigation block and at the lowest stream of the Guaraguao river and shall be a sluice way type of concrete box-culvert equipped with roller gate with flap which is designed for avoiding inflow of return flow.

(3) Wasteway

This structure shall be installed at the end of the secondary drainage canals which are constructed at influenced area of backwater coming from the Yuna and Barracote rivers where land elevation is lower than water level of backwater and shall be a sluice way type of concrete pipe protected by concrete structure around it.

(4) Road intersection works

This works shall be placed where drainage canals intersect roads with minimum soil coverage of 1.0 m and with installation of sheathing wall for jointing with earth canal. Concrete structure shall be employed.

(5) River intersection works

This works shall be constructed for draining excess water of the Ponton irrigation block into the Cascarilla canal at the time when water level of the Payabo increases due to influence of backwater of the Yuna river. The

construction site shall be downstream of the Payabo river from the confluence with the Guaraguao river. Siphon is a recommended type of the works with structure of two-row-concrete box culvert.

5.9.3 Flood Mitigation Works

As explained in detail in the section 5.7. flood mitigation works envisage improvement of cross section for the Payabo river and for the Cascarilla canal.

(1) Improvement works of the Payabo river

River section shall be expanded in accordance with design flood discharge. The elevation of crest of levee shall be raised up to 12 m.a.s.l. in such sectors as are subject to attack of backwater of the Yuna river.

(2) Improvement works of the Cascarilla canal

Same as the case of the Payabo river, section shall be expanded in accordance with design flood discharge. And, the elevation of the crest of levee shall be also raised up to 3.35 m.a.s.l.

5.9.4 Road Improvement Works

Road improvement works are composed of : (1) Rehabilitation of existing roads, (2) Construction of new roads, and (3) Construction of bridge and other related works.

(1) Road network

1) Trunk roads

Trunk roads have function to communicate major village within the area and rehabilitation of existing roads (the great majority) and construction of new roads (some portion) constitute proposed improvement works. Improved trunk roads shall have the total length of 8 m and the effective width of 6 m in view of simultaneous passage of large-scaled combine and ordinary vehicles.

Total length of trunk roads: 63,780 m (Intensity 5.3 m/ha)

2) Lateral roads

Road network to permit access of combine to farmlands is proposed. Taking solo passage of combine into account, lateral roads were designed as 6 m of total width and 4 m of effective width.

Alternative Plan	Total Length (m)	Intensity (m/ha)
A	167,200	25.1
B-1	189,350	23.9
B-2	180,920	24.1

3) In-farm roads

In-farm road (mainly along the Yuna river) shall be consolidated.

Total length : 8,800 m (Intensity 0.7 m/ha)

(2) Replacement/construction of bridges

The bridge spanning the Payabo river shall be replaced as the river section expands and new bridge shall be constructed over the Cascarilla canal where the trunk roads intersects this canal. Width of bridge is designed to be 6 m.

5.9.5 Land Preparation Works

For converting undulated grazing lands into paddy fields land preparation works is contemplated.

5.9.6 O/M Office

The project office for conducting O/M services of irrigation and drainage facilities shall be established. The office shall have 363 m^2 (11 m x 33 m) of area.

5.10 INSTITUTIONAL SERVICES AND RURAL ORGANIZATION DEVELOPMENT PLAN

For producing anticipated benefits of the present agricultural development project, it is prerequisite to strengthen both institutional services to support farmers such as provision of credit and extension of cropping technology and farmers' organization. The former target will not be attained without realizing organizational intensification of agencies responsible for rendering services, and this is a subject of too much load for a single project to solve it. Taking this matter into consideration, the proposal for strengthening institutional services will be limited to make some recommendations which may worth while to refer. Farmers' organization strengthening plan, on the other hand, will be formulated in line with two nucleus: upgrading existing farmers' organization and formation of an association affiliated by beneficiaries of irrigation works (water users' association).

5.10.1 Institutional Services Development Plan

(1) Transfer and extension of cropping technology

In the Dominican Republic, CEDIA is responsible for research and development of technology in relation with rice cultivation. CEDIA has contributed greatly to improvement of paddy productivity throughout the country, in particular, by developing and producing quality seeds represented by Juma 57 and Juma 58 which are highly suitable agro-climatological conditions of the country. CEDIA is also conducting research on adequate cropping technology including

mechanization at farm, and fruits of these efforts are exposed at its experimental farm or are introduced through its publications.

Despite the fact mentioned above, cropping technologies on paddy (planting density, application of fertilizers and agro-chemicals, etc.) developed by CEDIA have not been transferred appropriately to farmers of the Study area, which is associated with inferior level of productivity.

There may have various factors that relate with an absence of cropping technologies developed by CEDIA at farm level, but it is no doubt that lack of adequate extension services caused by shortage of extension workers and transportation constitutes the principal one. Furthermore, it is worth while to point out that, although there are two public agencies - SEA and IAD which take charge of extension services, coordination and collaboration between them are scarcely made.

Recommendations on improvement of transfer and extension of cropping technology are:

1. To establish an experimental farm administrated and operated by CEDIA within or in the vicinity of the Study area so that farmers in the area may be more accessible to innovated cropping technologies.

2. To establish a joint-committee participated by SEA, IAD, INDRHI, CEDIA and BAGRICOLA so as to exchange technical issues, views and problems related to crop and livestock production between concerned technical staff of each organization. It is advised that this joint-committee should prepare extension service programs in view of rendering effective services.

(2) Agricultural credit

The major portion of farmers in the Study area consist of farmers with holding of small and medium farm represented by settlers of agrarian reform project. These farmers, without access to commercial banks, have no other option but to rely on credit services provided by the BAGRICOLA. Farmers tend to complain of various aspects concerning with BAGRICOLA's credit services in such aspects as: interest rate together with commission is too elevated; the interval between application and disbursement is fairly long; repayment period expires very shortly; etc.

Meanwhile, the financing agency considers that problem of the agricultural credit services lies on lower proportion of repayment from the part of debtors; according the nearest branch of BAGRICOLA, about 40% of the disbursed credit fell into arrears in 1993. In such case, although the financing agency takes sanctions against dishonest debtors imposing additional interest for delayed repayment, no expected effect has been taken. As a consequence, BAGRICOLA goes decapitalized and its resources available for future financing becomes in shortage. For breaking a vicious circle between low proportion in repayment and

shortage of resources for agricultural credit, both the financing agency and its users are requested to make effort to on the matter.

The problems related with agricultural credit services are not specific ones coherent to the Study area but are in common all over the country; these problems are closely associated with agricultural policies of the central government, so political decision is required to solve them. Under the circumstances, recommendations will be made for fear that inadequate credit services should not constitute constraint on implementing agricultural development of the area.

1. To strengthen manpower and expand available amount of credit at BAGRICOLA's branch offices near the Study area so as to satisfy increased demand with implementation of the project.

2. BAGRICOLA's credit for settlers is not rendered individually but through associations or cooperatives organized by farmers; to train and educate leaders of these organizations so that their member farmers may become more sensible in management and repayment of their debt.

3. BAGRICOLA's credit services related with the Study area is extremely concentrated on rice cultivation (almost 97% of the total disbursement at the bank's Arenoso branch office); to diversify coverage of the credit to other crops and to other purposes than crop production such as purchase of agricultural machinery, equipment and vehicle, etc.

4. To create special line of credit applied for farmers' organizations; this credit, in turn, shall be provided to members of the organization who fail to get credit from BAGRICOLA.

5.10.2 Rural Organization Development Plan

(1) Farmers' organization

As far as rural organization is concerned, the are 121 associations, 5 cooperatives (formed by 52 associations) and 1 federation named as FALY (formed by 46 associations and 13 private farmers) in the Study area. There is another federation consists of 25 associations which is being organized now. These organizations have been formed under the auspices of IAD for promoting access to agricultural credit to be provided by BAGRICOLA, so no substantial activity is performed by these organizations except for FALY which administrates a rice mill.

Farmers' organizations strengthening plan shall have objectives to realize economical independence of these organizations by means of providing them with substantial economic base and to promote cultivating cooperativism among members of the organizations, and as a measure to attain these objectives, proposal is made to entrust administration and operation of six rice processing facilities contemplated in the "Marketing and Processing Plan of Agro-products"

to five cooperatives and one federation existing in the Study area. The medium and long term target of this plan is to expand activities of organizations after attaining the said economical independence in such fields as sale of agricultural inputs, rent of agricultural machinery, credit, sale of subsistence commodities, etc. and to return benefits of the organizations to their affiliated members so that enhancement of farmers' living standard may come true.

(2) Water users' association

The policy to turn over administration O/M of irrigation and drainage system from INDRHI to private organization formed by beneficiaries of these system called as "Junta de Regantes"(water users' association) is plays an important rote within the context of privatization policies of the Dominican Government, and this policy is already put into effect in some nationwide irrigation project areas. To follow this policy, it is proposed to organize Junta de Regantes within the Study area after completion of irrigation/drainage improvement works. Junta de Regantes is already formed at El Pozo area and INDRHI has plan to integrate this it with Juntas to be formed at Aguacate-Guayabo area and at Limon del Yuna area to realize rational performance of operation and maintenance services for irrigation/drainage system. Apart from this INDRHI's plan, this Study aims to facilitate forming and proper management of Junta de Regantes within Limon del Yuna project area.

The final target of turn-over policy of irrigation/drainage works is to entrust Junta de Regantes with the autonomous administration, operation and maintenance of all irrigation and drainage facilities from driving/trunk canals to tertiary system, but it is advised that , for some period after completion of facilities, the O/M services of the trunk canal should be undertaken by INDRHI.

The organization of water users is composed of "Asociacion de Regantes" and "Junta de Regantes"; the former will take charge of distribution of irrigation water to paddy fields and O/M of facilities while the latter, which is organized by the former, will decide and put into effect political and administrative matters of the organization including establishment of water charge to be imposed on water users.

The proposal for O/M of irrigation/drainage facilities by Junta de Regantes is explained in the Chapter 6 "Operation and Maintenance of the Project".

CHAPTER 6: IMPLEMENTATION, OPERATION AND MAINTENANCE OF THE PROJECT

CHAPTER 6: IMPLEMENTATION, OPERATION AND MAINTENANCE OF THE PROJECT

6.1 PROJECT EXECUTING AGENCY

INDRHI is a public agency of the Dominican Republic in charge of execution of irrigation and drainage project, therefore INDRHI is qualified to be the executing agency of the Project because major components of the present project are irrigation and drainage facilities. INDRHI has sufficient experience and is competent in carrying out detailed design, construction supervision and O/M of the irrigation and drainage facilities.

It is recommended that INDRHI undertakes during the implementation phase : 1) the employment of engineering consultant which will carry out the detailed design including topographic survey and geo-technical investigation, preparation of tender documents, tender evaluation and construction supervision, 2) award of contract for the construction of the project facilities through an international bidding, and 3) the undertaking of the O & M of the project facilities in collaboration with the water users' association (Juntas de Regantes).

Because the project area belongs to IAD's agrarian reform area and it is envisaged that new settlers will be introduced within the development area. It is thus essential that IAD would participate during the implementation stage of the project. IAD shall be in charge of establishing lands distribution plan and its execution.

6.2 PROJECT IMPLEMENTATION PROGRAM

(1) General

INDRHI, in collaboration with the Consultant to be employed, conduct detailed design and supervision services of construction works. The Consultant will assist INDRHI mainly in technical issues of project implementation. The contract for construction works shall be awarded exclusively to one contractor which shall take charge in procurement of all contsruction machinery, equipment and materiales necessary for construction works either at local market or international market.

(2) Budgetary allocation

The project costs except for the amount that the goverment of the Dominican Republic can appropiate as local currency portion will be financed by an international monetary institution.

(3) Award of contract for construction works

The contract for construction works shall be awarded to the successful tenderers in accordance with an international competitive tendering procedure.

(4) Project management office

It is recommended that a new project management office be established at La Reforma, where is located close to the development area. This project management office should be also used as the O & M office after completition of construction works.

(5) Cunsulting services

In compliance with the contract with the project executive agency, the Consultant will render necessary technical services for successful implementation of the project. The Consultant's services shall include, but not limited to, detaided design of construction works, preparation of tender documents, tender evaluation, and construction supervision. For conducting these consulting services, a total of 185 man-months are required with the following breakdown.

Service Stage	Foreign Man-month	Local Man-month	Total Man-month
Detailed Design	53	28	81
Construction Supervision	55	49	104
Total	108	77	185

6.3 PROJECT IMPLEMENTATION CALENDAR

As project preparatory period which comprises such activities as finance arrangement and employment of the Consultant 24 months will be taken, and the the project is schedulted to be implemented in 54 months, of which 14 months is allocated to detailed design services, 36 months to construction works, and 4 months for operation and maintenance works. The scope of the detailed design services includes, among others, topographic survey, geo-technical survey, detailed design of proposed structures and preparation of the tender document, meanwhile activities during the construction works comprise acquisition of proposed sites for construction works, tendering procedure for employment of contractor, construction works, procurement of machinery and equipment for operation and maintenance(O/M) of infrastructure, training of personnel who will take charge of O/M services, etc.

The above project implementation program is summarized in the figure below.

Components	Year in Order						
	1	2	3	4	5	6	7
Loan arrangement							
Detailed design							
Construction works							
- Preparator works							
- Roads							
- Drainage system							
- Irrigation ststem							
- Other works							
O/M services							

(1) Detailed design

In this phase detailed design services for structures included in the project shall be implemented. The present project does not contemplate structures which ask for sophisticated technology in detailed design and construction. Considerable period will be allocated to topographical and geo-technical surveys, because the project area is extensive where a lot of structures will be placed. Although standardization of design is foreseeable for small structures, major structures should be designed one by one in strict compliance with data obtained as a result of topographic and geo-technical surveys. After completing detailed design of structures (to be estimated in 14 months) a complete set of the tender document composed of the following documents will be provided.

- Prequalification document
- General specifications
- Tender form
- Breakdown of cost estimation
- Others
- General conditions
- Technical specifications
- Bill of quantity
- Implementation schedule of construction works

(2) Construction period

In this stage the following works will be carried out.

1) Land acquisition

Prior to commencement of the construction works, INDRHI is requested to take necessary measures to acquire lands for proposed sites for construction of project office, intake works, canals, roads, etc.

2) Tendering and award of contract

After editing complete set of the tender documents, prequalification of contractors and short listing of prequalified contractors will be made. The successful tenderer who is entitled to be invited for the contract negotiation will be nominated through international competitive tendering procedure. It is anticipated that the construction works will be completed within 36 months.

3) Construction works

For realizing effective implementation of construction works, it is advisable that road construction to facilitate smooth access of construction machinery and vehicle should be put into implementation in advance to other components of the construction works; subsequent to this road construction works it is deseable that drainage system improvement works should be commenced demarcating its component between rainy season's category and dry season's category. In case that saving of construction period should be essential, it is advised that the division of the development area by the fluvial line consists of Guaraguao river - Payabo river will be proposed at the detailed design stage.

4) Training in O/M of infrastructure

Starting two months before the completion of the construction works, preparation of manuals on operation and maintenance (O/M) of irrigation/drainage works as well as training of personnel of Junta de Regantes in relation with irrigation canals and other works will be made for the lapse of 4 months. Training item shall comprise, but not limited to, operation, check-up and repair of water gate, establishment of regulation on water distribution, disposal method of excavated soils, operation and maintenance of machinery and equipment.

6.4 PROJECT COST ESTIMATE

6.4.1 Conditions for Estimation

The project cost has been estimated in due compliance with the following conditions.

(1) Cost of machinery, equipment and materials

The construction works will be carried out by the contractors according with the contract with the project executing agency. The contractors shall be responsible for procurement of machinery, equipment and materials to be used for construction works and the cost of machinery and equipment is included in the depreciation cost.

(2) Unit rate

The unit rates of wages, materials, equipment and machinery are estimated based on the current price prevailing in the Dominican Republic.

(3) Demarcation of foreign currency portion and local currency portion

Each component of the construction works is divided into foreign currency portion and local currency portion; the former price is estimated based on CIF at port of Santo Domingo as of June 1995 and the latter is on the market price at the proposed project site of the country.

(4) Foreign exchange rate

The foreign exchange rate applied for this estimate is US$ 1.00 = RD$ 12.87, an official rate as of March 1995.

6.4.2 Estimated Project Cost

The total cost of the project is composed of : (1) Consulting services, (2) Land acquisition, (3) Construction works, (4) Operation and maintenance of the project, (5) Physical contingency, and (6) Price escalation.

(1) Construction works

Work Category	Alternative Plan A			Alternative Plan B-1			Alternative Plan B-2		
	Local P.	Foreign P.	Total	Local P.	Foreign P.	Total	Local P.	Foreign P.	Total
1. Preparatory works	3,274	5,729	9,003	3,623	7,170	10,793	3,566	7,038	10,604
2. Water intake works	6,313	14,378	20,691	6,580	24,054	30,634	6,580	24,054	30,634
3. Irrigation system	65,737	57,490	123,227	70,650	67,936	138,586	69,896	67,237	137,133
4. Drainage system	16,477	16,325	32,802	19,772	21,632	41,404	19,102	20,622	39,724
5. Flood mitigation works	1,779	20,235	22,014	1,779	20,235	22,014	1,779	20,235	22,014
6. Roads works	14,163	75,228	89,391	15,363	82,589	97,952	14,946	80,038	94,984
7. Land preparation works	-	-	-	2,063	17,729	19,792	1,605	13,795	15,400
8. Office for O/M services	1,408	1,584	2,992	1,408	1,584	2,992	1,408	1,584	2,992
Total	109,151	190,969	300,120	121,238	242,929	364,167	118,882	234,603	353,485

(2) Land acquisition

In the Dominican Republic, habitual practice for land acquisition on proposed sites for construction works is not by means of expropriation but by compensation for reconstruction or removal of house and for loss in agricultural production. This cost is estimated to be RD$ 5,000,000 referring to the experience of the AGLIPO I Project.

(3) Purchase of machinery and vehicles for O/M services

For use of O/M services of the project and routine maintenance works of project facilities, the following machinery and vehicles should be procured by INDRHI and "Junta de Regantes". These machinery and vehicles should be replaced according with their durable period.

Unit RD$ 1000

INDRHI				Junta de Regantes			
Items	Spec.	Nos.	Amount	Items	Spec.	Nos.	Amount
Excavator	0.6-0.7 m^3	1	1,723	Excavator	0.3-0.4 m^3	2	2,432
Dump truck	11 ton	3	5,043	Excavator	0.6-0.7 m^3	1	1,723
				Dump truck	11 ton	3	5,043
				Motorgrader	3.7 m	1	1,757
				Pick-up	2 ton	1	376
				Motorcycle	125 cc	10	376
				Equipment for education and extention		1	200
Total			6,840				11,907

(4) General administration expenses

Consumable goods, office furniture and equipment, wages of personnel and other relavant expenses which are deemed to incur in connection with the administration and operation of the project office are included in this category. Estimated cost for these expenses is RD$ 500 million making reference to the AGLIPO I project.

(5) Consulting services

Cost for the consuting services is estimated as follows:

Unit: RD$ x 1000

Work Category	Foreign Currency	Local Currency	Total
Detailedesing	21,294	4,468	25,762
Construction supervision	24,013	5,038	29,051
Total	45,307	9,506	54,813

(6) Physical contingency

The phycial contingency shall be 10% of the sum of costs for the above-mentioned components (1) - (5).

(7) Price escalation contingency

The price escalation contingency is to be estimated at 4.1% based on converted price of Dominican peso into US dollars.

(8) Total sum of the project cost

Suming up each component mentioned above, the total cost of the project reaches as given in the table below.

	Alternative Plan A			Alternative Plan B-1			Alternative Plan B-2		
Category	Local P.	Foreign P.	Total	Local P.	Foreign P.	Total	Local P.	Foreign P.	Total
1. Construction works	109,150	190,970	300,120	121,238	242,929	364,167	118,882	234,603	353,485
2. Land Acquisition	5,000	0	5,000	5,000	0	5,000	5,000	0	5,000
3. O/M machinery	0	18,673	18,673	0	18,673	18,673	0	18,673	18,673
4. General expenses	5,000	0	5,000	5,000	0	5,000	5,000	0	5,000
5. Consulting services	9,506	45,307	54,813	9,506	45,307	54,813	9,506	45,307	54,813
Sub-total (1-5)	128,656	254,950	383,606	140,744	306,909	447,653	138,388	298,583	436,971
6. Physical contingency	12,665	25,495	38,360	14,074	30,691	44,765	13,839	29,858	43,697
Sub-total (1-6)	141,521	280,445	421,966	154,818	337,600	492,418	152,227	328,441	480,668
7. Price escalation	12,347	27,663	42,011	15,758	33,980	49,738	15,486	32,987	48,473
Total (1-7)	153,868	308,108	463,977	170,576	371,580	542,156	167,713	361,428	529,141

6.5 OPERATION AND MAINTENANCE

6.5.1 Operation and Maintenance Organization

(1) Proposal for operation and maintenance of irrigation system

In conformity with INDRHI's policy to turn over irrigation system to water users, water users' association named as "Junta de Regantes" shall be formed at the beginning of the project so that INDRHI may take charge of rendering training services to the water users' association in the course of the progress of the construction works and the water users' association will be able to supervise the workmanship and progress of the construction works. The substantial functioning of the "Junta de Regantes" shall be after completion of construction works when transfer of technology together with training to water users will have been completed by member of the Consulting firm. In principle, "Junta de Regantes" shall take charge of operation and maintenance (O/M) of secondary, tertiary and on-farm irrigation system, while INDRHI's control and responsibilities shall remain on water intake system, main canal and drainage system; so far as the present project is concerned, in view of the fact that sources of irrigation water are dispersed and intake works proposed for each source are relatively small in scale, it is recommended that Junta de Regantes should take charge of all facilities including intake facilities and main canals. For providing O/M services, offices for INDRHI and "Junta de Regantes" shall be established within the Study area; it is advised that for close communication and coordination between these two organizations, these offices should be located in the same site.

One of the constraints which affect on productivity of paddy in the Study area is insufficient O/M services of irrigation/drainage services provided by INDRHI. Therefore it is extremely important that INDRHI's office should be equipped with machinery and vehicles (excavator, dump truck, motor grader, pick-up, etc.) for rendering proper O/M services as well as qualifies manpower (water charge administrator, heavy-machinery operator, gates operator, etc.) to take charge of the services. Junta de Regantes is also needed to procure and recruit said machinery and personnel.

Junta de Regantes to be formed under the project does not have experiences in O/M of irrigation system, so INDRHI's assistance to the following aspects is essential.

- To train and support in organizing "Junta de Regantes"
- To give advise on administration and management of O/M office
- To transfer technology and know-how in relation with O/M of irrigation system
- To prepare O/M manual for proper functioning of the system

- To render advisory services on establishment, collection and management of water charge

- To coordinate in getting finance for working capital of the "Junta de Regantes"

(2) Irrigation water management

As mentioned before, sources of irrigation water are dispersed and available discharge for respective source is limited, so proper management of irrigation water is a critical task. Distribution of irrigation water to the benefittable lands will be determined taking the actual cropping pattern and weather conditions into account. In this context, it is essential that SEA and IAD would participate in the project at the stage of planning irrigation water distribution.

Water to be stored at reservoir will be supplied from the Guaraguao river, which means that this irrigation system will be faced with competition with other irrigation systems in drawing water from the said source. In this regard, it is suggested that distribution of water to the reservoir should be made during the period of less water requirement (June and subsequent some months) so that stored water at reservoir should be used in time of unexpected drought.

(3) Drainage and flood management

Growth of aquatic plants and weeds within drainage canals is observed to be remarkable. If measures aginst this growth should not be taken, the drainage capacity of canals would be deteriorated badly. Thus, routine cleaning and clearing tasks of canals are of importance accordingly. Romoval work of aquatic plants and weeds at the time of significant growth brings about more excavation works, which will result in expansion of canal section and reduction of road width. It is thus advised that canal cleaning task should by carried out by manpower frequently.

6.5.2 Operation and Maintenance Organization

It is advaisable the the office for operation and maintenance(O/M) of irrigation and drainage facilities would be located at La Reforma as case with the project office. Both offices for INDRHI and Junta de Regantes will be installed at the same lot and this lot should have considerable space to keep machinery and materials for O/M services. The inter-relation between INDRHI and Junta de Regantes is illustrated in Fig. H.6.1.

(1) Responsibilities of INDRHI and Junta de Regantes

Responsibilities for O/M services of irrigation and drainage facilities shall be demarcated between INDRHI and Junta de Regantes in the following manner.

INDRHI: shall be responsible for O/M of intake facilities (reservoir and pumping station), main drainage canal, river levee, etc; provide Junta de Regantes with technical and managerial advices; coordinate with institutions concerned with disaster prevention.

Junta de Regantes: shall be responsible for O/M of intake facilities (other than reservoir and pumping station), irrigation canals (main, secondary and tertiary systems) and drainage canals (secondary and tertiary systems); establishment and collection of water charge; responsibilites for respective level of are as follows:

a. Nucleos de Regantes:

The unit shall be responsible for distribution of water from final gate to paddy fields, O/M of irrigation and drainage canals, collection of water charge, coordination for organization among water users as well as for settlement of disputes among members. Representative of each "nucleos" shall participate in "Asociacion de Regantes"

b. Asociacion de Regantes:

This is an organization to be formed for each water intake unit and shall take charge in O/M of lateral irrigation and drainage canals and in settlement of disputes among "nucleos". Representative of each "asociacion" shall participate in "Junta de Regantes".

c. Junta de Regantes:

This is the highest level of water users' association and shall be responsible for O/M of whole irriganation and drainage system to cover the irrigation project area. President of this unit will be selected among members by vote of all affiliated members.

d. Operation Office

The operation office for Junta de Regantes shall be managed by office manager and assisted by recruited personnel who will take charge of O/M of completed works (Organization chart is as per Fig. 6.6.1).

(2) Composition of Junta de Regantes

Taking proposed irrigation network into account Junta de Regantes will be composed of the following units.

Junta de Regantes	Irrigation Block	Asociacion de Regantes	Nucleos de Regantes		
			Plan A	Plan B-1	Plan B-2
Limon del Yuna	Payabo	Payabo main canal	11	26	26
	Ponton	Ponton main canal	16	22	16
		Arrenquin main canal	14	15	15
	Guaraguao	Guaraguao main canal No.1	39	36	36
		Guaraguao main canal No.2	17	27	27
		Reservoir	7	-	-
	La Cueva	La Cueva main canal	8	9	9
		El Cercado main canal	6	6	6
	Lagnita Cristal	Lagnita Cristal main canal	14	14	14
	Borojol	Borojol main canal	20	23	23

(3) Manpower and budget of INDRHI's office

INDRHI's office shall consist of the following manpower and will require an annual budget of RD$ 606,000.

General manager (1), Section manager (2), Secretary (3), Driver (3), Accountant (1), Administrative staff (1), Communication staff (1), Clerk (1), Watchman (1), O/M engineer (1), Operator (4), Assistant operator (4), Mechanic (1), Assistant mechanic (1), Agronomist (1) and Assistant agronomist (1)

(4) Manpower and budget of Junta de Regantes' office

Junta de Regantes' office shall consist of the following manpower and will require an annual budget of RD$ 2,626,000.

Office manger (1), Section manager (5), Water charge accountant (1), General accountant (1), Topographic engineer (1), Assistant topographic engineer (1), Operator (4), Assistant operator (4), Dump truck operator (6) Driver (1), Mechanic (1), Assistant mechanic (2), Mason (1), Irrigation engineer (8), Secretary (1), Clerk (1) and Watchman (1)

(5) Establishment of the Environmental Supervision and Control Committee (CVCA)

For the purpose of accomplishment of environmental issues and recommendations, it is proposed under the "Irrigation System Administration Program by Water Users" to be proceeded by INDRHI to create the Environmental and Supervision and Control Committee (CVCA) within an influential area of Juntas de Regantes and at the central office of INDRHI.

The basic functions of the CVCA shall comprise, among others,:

- To plan and coordinate the activities which permit the follow-up and control of the environmental transformation to be produced in the programming stage.

- To coordinate and supervise that the environmental recommendations and issues to be presented in the Environmental Impact Assessment should be put into force.

- To integrate the cooperation among the representatives of INDRHI responsible for turn-over of irrigation system, the representatives of Juntas de Regantes, the representatives of Provincial and Municipal government so that the said arrangement should be accomplished.

- To prepare the guidelines, regulations and standards which will serve to comply with functions of the CVCA.

Following the above proposal of INDRHI, the CVCA will be established as a part of Juntas de Regantes to be organized at the Limon del Yuna irrigation project area.

6.5.3 Water Charge

Water charges applied to water users of irrigation system in the Dominican Republic is based on the guidelines and rules for operation defined in the Government Regulation No. 555 on Water Charge dictated in 1982. And, in the face of low proportion for collection of water charge, the Government Decree No. 435-90 was dictated in 1990 in view of valuation for collection factor for different irrigation canals and districts.

The valuation of collection factor is made in the following manner:

$$FC = M/(SFm1 + 2*Sfm2 + 2*SA1 + 4*SA2$$

where:

FC = Collection Factor (Factor de cobro)

M = Total amount of annual budget for administration, operation and conservation of the irrigation area plus some portion of expenses of the district office.

SFm1 = Total area of lands with farm size up to 10 ha. used for minor crops plus the area which results in summing the first 10 ha of lands which exceed the said area used also for minor crops.

SFm2 = Total area exceeding 10 ha of lands used for minor crops.

SA1 = Total area of lands with farm size up to 10 ha. used for paddy plus the area which results in summing the first 10 ha of lands which exceed the said area used also for paddy.

SFm2 = Total area exceeding 10 ha of lands used for paddy

The water charges applied to irrigation water users are:

TFm1 = FC, TFm2 = 2*FC, TA1 = 2*FC and TA2 = 4*FC

where:

TFm1 = Annual water charge per ha to be collected from water users who cultivate minor crops in lands both smaller 10 ha and first 10 ha of lands which exceeds the said area.

TFm2 = Annual water charge per ha to be collected from water users for each ha or additional fraction to first 10 ha which own, used for minor crops

TA1 = Annual water charge per ha to be collected from water users who cultivate paddy in lands both smaller 10 ha and first 10 ha of lands which exceeds the said area.

TA2 = Annual water charge per ha to be collected from water users for each ha or additional fraction to first 10 ha which own, used for paddy

In accordance with the said water charge system, water users in the Limon del Yuna project area paid in 1994 water charges on the basis of the collection factor at RD$ 175.37/ha.

Water charge "With" project shall be calculated in accordance with the following premises.

(1) Description of O/M services

O/M Facilities		Length (Structures)	Responsible Agency	Contents of Services	Necessary Machinery, etc
Intake Works		Pump, Reservoir	INDRHI	General O/M, Oil Supply	
Irrigation Canal	Main	96 km (Concrete)	Junta de Regantes	Removal of Sedimentation, O/M of gates and pumps	Manpower Dump truck
	Secondary	69 km (Earth)			
	Tertiary	217 km (Earth)			
Drainage Canal	Main	9 km (Earth)	INDRHI	Removal of Sedimentation, Weed Control	Excavator Dump truck
	Secondary	72 km (Earth)	Junta de		
	Tertiary	166 km (earth)	Regantes		
Road	Main	64 km (Gravel)	SEOPC	Gravel Filling Leveling	Motor Grader Dump truck
	Lateral	167 km (Gravel)	Junta		
	Levee	49 km (Gravel)	INDRHI		
	Within Village	9 Km (Gravel)	SEOPC		

(2) Annual operation and maintenance cost

An annual cost for O/M services including training services to be rendered by INDRHI to Junta de Regantes is estimated for respective office of INDRHI and Junta de Regantes as given below.

		INDRHI			Junta de Regantes			
		Nos.	Cost (RD$)			Nos.	Cost (RD$)	
			Plan A	Plan B			Plan A	Plan B
Lease of O M Machinery	Excavator	1	58,000	65,000	Excavator	3	458,000	536,000
	Dump truck	3	165,000	185,000	Dump truck	3	666,000	722,000
					Motor grader	1	293,000	342,000
	Sub-total		223,000	250,000	Sub-total		1,418,000	1,600,000
Materials			19,000	21,000			135,000	150,000
Fuels			32,000	36,000			226,000	259,000
Sub-total			304,000	341,000			2,713,000	3,128,000
Office Expenses			541,000	541,000			2,692,000	2,692,000
O M for pumps				999,000			204,000	204,000
Equipment for Education and Extension						1	40,000	40,000
Total			845,000	1,881,000			5,649,000	6,064,000

(3) Establishment of water charge "With" project

In accordance with the above premises water charges to be imposed on beneficiaries of irrigation/drainage system are established as follows:

	Alternative Plan A	Alternative Plan B
M(RD$)	6,494,000	7,945,000
SA1(ha)	13,300x0.7+80x10 =10,110	15,720x0.7+80x10 =11,804
SA2(ha)	13,300x0.3-80x10 =3,190	15,720x0.3-80x10 =3,916
FC(RD$)	6,494,000/(2x10,110+ 4x3,190)=197	7,945,000/(2x11,804+ 4x3,916)=202
TA1(RD$/ha)	2x197=394	2x202=404
TA2(RD$/ha)	4x197=788	4x202=808

In short, water charge to be imposed on paddy fields is as follows.

Unit: RD$/ha

	Alternative Plan A		Alternative Plan B	
	Farm size (Up to 10 ha)	Farm size (10 ha & larger)	Farm size (Up to 10 ha)	Farm size (10 ha & larger)
Actual situation	175	350	175	350
With project	394	788	394	788

CHAPTER 7: PROJECT EVALUATION

CHAPTER 7 : PROJECT EVALUATION

7.1 OBJECTIVE OF PROJECT EVALUATION

The objective of the present project evaluation is to assess the viability for implementation of the Limon del Yuna Area Agricultural Development Project from the viewpoint of the national economy. Apart from this economic evaluation, financial analysis on the basis of profitability at farm level shall be realized in view of the fact that, even if the implementation of the present agricultural development project is proved to be justifiable from the standpoint of the national community taken as a whole , there is no guarantee for the project to be adopted unless it is attractive to farmers from financial point of view. In addition to these economic and financial evaluation and analysis, the indirect effects of the project shall be discussed.

7.2 PROJECT EVALUATION METHOD

The present project evaluation has been conducted in compliance with the methodology that is commonly applied for evaluation of development projects in the Dominican Republic under finance of the Word Bank, Inter-American Development Bank, etc. This methodology is, in sum, to identify and value the project costs and benefits that will arise "with" the project and to compare them with the situation as it would be "without" the project. Once economic pricing has been established for both project costs and benefits, cash flow consisting of these economic costs and benefits will be prepared to cover the whole project life and on the basis of this cash flow the economic internal rate of return (EIRR) that set the discounted economic net benefit stream (discounted economic benefits minus discounted economic costs) equal to zero will be calculated. This project is considered acceptable if the EIRR exceeds the opportunity cost of capital in the Dominican Republic.

The shadow prices used for converting market prices into economic prices are based on the "Guia metodologico para la preparation y presentacion de proyectos agroindustriales, Fondo de Inversiones para el Desarrollo Economico (FIDE), 1989".

Costs and benefits of the project at the implementation phase are subject to increase/decrease as an outcome of fluctuation in yield, prices and other parameters affected by the change of project circumstances from the time of project evaluation for the feasibility study, so sensitivity test shall be conducted to find out what parameters shall have the strongest effect on the project profitability for a given percentage variation (increase in construction and O/M cost, decrease in yield, extension of construction period and combination of these variations).

The financial analysis at farm level shall be made by comparing farm profitability under the situation between "with" and "without" project among established some model farms according with land tenure, farm size, land use and cropping pattern. For this financial analysis market price for calculation of both income and expenditure shall be adopted. The purpose of this financial analysis is to assess if farmers can get higher return "With"

project than that of "Without" project or not, even if they are imposed higher water charge to cover elevated O/M cost.

7.3 COMPONENT OF THE COSTS AND BENEFITS OF THE PROJECT

Costs of the project

The costs of the project which are subject to project evaluation shall consist of the initial investment and operation and maintenance cost.

1) Initial investment

- Construction works
- Acquisition of machinery and equipment for O/M services for irrigation/drainage works
- General administration cost of the project office
- Consulting services
- Physical contingency

2) Operation and maintenance cost (Balance of cost between "With" project and "Without" project

- Annual operation cost of irrigation and drainage facilities
- Replacement of structures and machinery according with their durable life.

Benefits of the project

1) Irrigation/drainage benefit (Incremental crop production attributable to expansion of irrigable area as well as to improvement of productivity)

   Balance of the net return for the whole development area between "With" project situation and "Without" project situation

2) Flood mitigation benefit (Avoidance of loss in agricultural production)

   Estimated damage to be caused by flooding at "Without" project situation = inundable area of paddy fields at return period of 1/2 x return period of flooding x proportion of loss for agricultural production x value of agricultural production.

Project's costs and benefits valued at financial price are as given below:

Unit:RD$ x 1000

Cost Items	Alternative A	Alternative B-1	Alternative B-2
Construction Works	300,120	364,167	353,484
Acquisition of Machinery	18,673	18,673	18,673
General Administration	5,000	5,000	5,000
Consulting Services	54,813	54,813	54,813
Physical Contingency	37,861	44,265	43,197
Total of Investment Cost	416,467	486,918	475,167
O/M Cost (Year)	3,871	4,503	4,503
Replacement of machinery	18,673	18,673	18,673
Replacement of structures	3,540	19,840	19,840

Unit RD$ x 1000

Items	Alternative A	Alternative B-1	Alternative B-2
Incremental Net Return of Agricultural Production	102,264	111,876	108,780
Avoidance of Loss in Agricultural Production	2,405	2,405	2,405
Total	104,669	114,281	111,185

7.4 VALUATION OF PROJECT'S COSTS AND BENEFITS AT ECONOMIC PRICE

7.4.1 Farm-gate price

For the purpose of valuing economic price, crops and livestock products which are contemplated in both "With" and "Without" project situation are divided into two categories: traded items and non-traded items; the economic farm-gate price (economic import/export parity price) for the former is valued at border prices and that for the latter is obtained multiplying financial (market) price by conversion factor for consumer goods.

Economic farm-gate prices for crop and livestock products contemplated in the project are obtained as given below (See Table L.4.1 for basis of calculation).

Unit (RD$/ton)

Category	Crops	Financial	Economic
Traded Items	Rice	4,500	3,139
	Maize	1,938	2,364
	Haricot Bean	7,707	10,520
	Milk	3,730 *	1,907 *
Non-traded Items	Sweet potato	1,122	909
	Cassava	1,583	1,282
	Vegetables	4,323	3,502
	Cattle	3,474 **	2,814**

Note: * RD$/kilolitcr, ** RD$/head

7.4.2 Production cost

The financial production costs was converted to economic cost by means of elimination of direct transfer items and adjustment for price distortions in traded commodities and non-traded commodities by multiplying financial price with conversion factor.

As a consequence of the elimination and adjustment cited above, the production cost of crops and cattle farming expressed in economic term is obtained in the following manner (Refer to Table L.4.2).

Unit RD$/ha

	Without Project		With Project	
Crops	Financial	Economic	Financial	Economic
Rice	15,095	11,141	15,720	11,400
Maize	4,703	3,082	5,764	3,810
Haricot bean	10,592	7,535	13,210	9,506
Sweet potato	7,521	4,366	9,136	5,343
Cassava	6,201	3,435	7,624	4,273
Vegetables	12,756	9,008	15,886	11,345
Cattle farming	10,898	7,186	10,898	7,186

7.4.3 Project Benefits

On the basis of the economic farm-gate price and production cost calculated above, the benefits of the project (incremental net return of agricultural production and avoidance of loss in agricultural production) at economic price is estimated in the following manner.

Unit RD$ x 1000

Items	Alternative A	Alternative B-1	Alternative B-2
Incremental Net Return of Agricultural Production	66,597	74,517	73,443
Avoidance of Loss in Agricultural Production	1,678	1,678	1,678
Total	68,275	76,195	75,121

7.4.4 Project Costs

The project costs valued at market price are broken down into: traded commodities, non-traded commodities, skilled labor cost, unskilled labor cost and indirect cost, and market prices for each component are converted into economic prices in accordance with adjustments explained in the Annex L.5. Economic costs for initial investment and operation and maintenance cost are thus obtained as follows:

Unit:RD$ x 1000

Cost Items	Alternative A	Alternative B-1	Alternative B-2
Construction Works	249,100	302,259	293,392
Acquisition of Machinery	17,179	17,179	17,179
General Administration	4,350	4,350	4,350
Consulting Services	53,168	53,168	53,168
Physical Contingency	32,380	37,696	36,809
Total of Investment Cost	356,177	414,652	404,898

	Alternative A	Alternative B-1	Alternative B-2
O/M Cost (Year)	3,067	3,826	3,826
Replacement of machinery	17,179	17,179	17,179
Replacement of structures	3,256	18,253	18,253

7.5 ECONOMIC ANALYSIS

7.5.1 Economic Internal Rate of Return (EIRR)

The annual inflow (benefits) and outflow (costs) at economic price have been determined as mentioned before and, as a consequence, the annual incremental net benefit (annual benefit minus annual cost) is incorporated to cover the whole project life, which is set as 50 years for the project under consideration. On the basis of annual flow (cash flow) of the incremental net benefits (Refer to Table 7.5.1), the economic internal rate of return (EIRR) is estimated to be 14,7% for the Alternative Plan A, 14.1% for the Alternative Plan B-1, and 14.2 % for the Alternative Plan B-2. Any of these rates excels the discount rate of 12 % which was set by the Central Bank and considered as the opportunity cost of the capital in the Dominican Republic. Therefore, all of three Alternatives have been justified from economic point of view.

7.5.2 Sensitivity Analysis

The objectives of the sensitivity analysis is to modify assumptions on key variables (benefits, costs and time for completion of the project), and to test how the project's economic internal rate of return , and hence its viability, is affected by these different scenarios. This analysis permits a judgment as to the risk of the project under alternative assumptions. The following assumptions on key factors were made for the present project:

- Unit yield of paddy is declined by 10% (Case 1)
- Project cost is escalated by 10% (Case 2)
- Combination of the Case 1 and the Case 2 (Case 3)
- Completion of construction works is delayed by 2 years (Case 4)

Project's EIRR was affected for respective assumption in the following manner:

Assumptions	EIRR (%)		
	Alternative 1	Alternative B-1	Alternative B-2
Case 1	13.3	12.7	12.9
Case 2	13.4	12.8	13.1
Case 3	12.1	11.9	11.7
Case 4	13.0	12.5	12.7

The above analysis disclosed that the profitability of the project is more sensible to the delay of completion of construction works than decline of unit yield and escalation of project cost.

7.6 FINANCIAL ANALYSIS

7.6.1 Profit-and-loss analysis at model farms

At level of farmers, the implementation of the present project will bring both positive and negative effects; the former is represented by expansion of cultivated area and enhancement of land productivity and the latter is expressed in the form of rise in water charge and reduction of arable land. Under the circumstances, so as to quantify these effects profit-and-loss analysis at farm level was made by establishment of various model farms in accordance with land tenure, farm size, crop, and, cultivated area. A total of 6 model farms have been established with following characteristics:

Model Farms	Land Tenure	Farm Size (ha)		Crops		Cultivated Area (ha)	
		Without	With	Without	With	Without[1/]	With[2/]
A	IAD	3.8	3.8	Paddy	Paddy	4.9	6.8
B	IAD	1.6	3.0[3/]	Paddy	Paddy	2.1	5.4
C	IAD	9.0	9.0	Pasture	Paddy	9.0	16.2
D	Private	5.8	5.8	Upland	Paddy	2.0	6.8
E	Private	40.0	30.0[4/]	Paddy	Paddy	47.0	51.0
F	Private	180.0	135.0[4/]	Pasture	Paddy	180.0	243.0

Note: With - With Project, Without - Without Project
1/ - Farm size x 0.9 (proportion of net irrigable area) x 1.4 (actual cropping intensity)
2/ - Farm size x 0.85 (proportion of net irrigable area) x 2.0 (proposed cropping intensity)
3/ - With assumption that redistribution of land should be made
4/ - With assumption that one-quarter of land should be expropriated according with "Quota Part" law

In relation with above model farms profit-and-loss analysis under both "With" and "Without" projects is made on the basis of market price and the result of the same is summarized in the table below (Refer to Table L.7.1). Water charges employed for this analysis is RD$ 175.22/ha for the "Without" project case and RD$ 394.00/ha for the "With" project case.

Net Return (RD$/year)	Model Farm					
	A	B	C	D	E	F
Without Project	1,446	620	16,458	11,620	13,865	929,160
With Project	49,545	39,344	115,550	49,545	355,432	1,757,453
Increased Net Return	48,099	38,725	69,092	37,925	341,567	828,293

7.6.2 Financing Plan

The project costs may be divided into foreign currency portion and local currency portion and their annual disbursement schedule (Alternative Plan B-1 - the highest cost among three alternatives) is as shown below.

Unit: RD$ x 1000

Year	Foreign Currency	Local Currency	Total
1	19,935	5,283	25,218
2	27,649	12,327	39,976
3	149,795	70,643	220,438
4	130,053	68,914	198,967
5	44,148	13,409	57,557
Total	371,580	170,576	542,156

Of the said project cost, foreign currency portion will be procured by loan from international financing institution and local currency portion will be arranged by the Dominican Government.

Provided that loan for the foreign currency portion should be provided on the condition that:

- Interest : 3% per annum
- Repayment term: 20 years (grace period: 10 years)

the maximum amount to be repaid shall be RD$ 29,169,000, which falls on 11th year of amortization. (See Table 7.7.1).

7.7 PROJECT'S INDIRECT BENEFITS

As mentioned before, the implementation of the present project will produce such directs benefits as incremental agricultural production owing to improvement of irrigation and drainage conditions and avoidance in agricultural loss to be brought by flood mitigation. And, apart from these direct benefits, it is anticipated that the project would accompany indirect benefits to be explained hereinafter.

(1) Contribution to development of agro-industry both within and out of the Study area and to encouragement of local economic activities

An annual production of paddy is expected to increase from 32,000 ton/year to 70,000-80,000 ton/year, and this incremental production will encourage to promote development of rice processing industry as well as elevating operation efficiency of existing plants. Simultaneously, in parallel with expansion of cultivated area of paddy, demand for fertilizers, agro-chemicals, and agricultural machinery services will increase, which contributes to make local commercial activities prosperous.

With development of these agro-industrial and commercial activities, activation of regional economy will come true.

(2) Promotion for strengthening rural organization

The present agricultural development plan to proposes develop rice processing facilities to be administrated and operated by farmers' organization within the Study area. With realization of this proposal, the existing farmers' organization, which have no substantial function nor activity at present, will be provided opportunity for conducting fruitful economic activity. Furthermore, with achievement of successful administration of rice processing facilities, farmers' organizations will become capable of expanding their activities to such fields as sale of agricultural inputs, rent of agricultural machinery, and credit services, and benefits to be produced through farmers' organization will be returned to members of the organizations.

Besides above-mentioned cooperative organizations, improvement of irrigation/drainage system will facilitate formation of water users' association within the Study area. Thus, implementation of the present project is highly beneficial in terms of strengthening rural organization.

(3) Creation of opportunity for employment

Expansion of cultivated area of paddy also promises to provide more job opportunity of farm labor and development of agro-industry will take local inhabitants into new employment. Furthermore, implementation of construction works will create wide variety of employment, although it is a short-term basis.

(4) Contribution to self-sufficiency of rice

In the Dominican Republic, rice has been imported for eight years of the last decade and it is forecasted that there will be a deficit of 200 thousand tons of rice for the coming year of 2015 if the country's population would grow following the actual trend. The Limon del Yuna Agricultural Development Project envisages to increase rice output by 70,000 tons per year, so implementation of this project contributes to offset one-third of national deficit of rice.

(5) Saving of fuel

The prevailing poorly functioning irrigation system forces farmers to rely considerable portion of irrigation water on pumping system and farmers bear a cost of RD$ 3,647,000 (total annual amount in the Study area) for operation and maintenance of pumping irrigation system in addition to water charge payable to INDRHI. Enhancement of gravity irrigation system discourages farmers to use pumps and, as a consequence, saving of fuel required for operation of pumps will be realized.

7.8 MONITORING AND EVALUATION OF THE PROJECT

The Monitoring and evaluation is a practical and effective methodology to assess the progress of the project under implementation and to monitor from time to time whether this progress is as scheduled or not. This methodology enables at the same time to verify the amount of project inputs (costs) and outputs (benefits). Items to be monitored and evaluated are as listed below.

Items	Construction Stage		After Completion		Monitoring Indicators
	First Half	Second Half	5th Yesr	10th Year	
I. Project Description					
1. Project Purpose	○		○	○	Farmers' income No. of rice mill
2. Project Scope and Dimensions					Irrigated area
(1). Comparison of Original Scope / Dimensions and Actual one	○		○	○	No. of beneficiaries
(2). Reasons for Revision / Modification of Scope and Dimensions	○		○	○	No. of farms
II. Project Implementation					
1. Organization for Implementing the Project	○				Participated organizations
2. Construction period					
(1). Comparison of original Schedule and Actual Period		○			Actual period
(2). Reasons for Delay or Early Completion		○			
(3). Remedial Actions taken in Each Case of Delay		○			
3. Construction Cost					
(1). Comparison of Original Estimated Cost and Actual Expenditure		○			Actual Expenditure
(2). Reasons for the difference between the Original Estimated Cost and Actual Expenditure		○			
(3). Actions Taken in the Case of Cost overrun		○			
(4). Expenditure by Year		○			
4. Comments on the Performance of Consultant and / or Contractor / Supplier		○			
III. Action Taken by Borrower and / or Executing Relating to Recommendation(s) (if any)		○			
IV. Amortization	○	○	○	○	Annual payment of interest Repayment of the capital
V. Operation and Maintenance after Project Completion					
1. Present Condition of the Facilities			○	○	Remaining facilities
2. Organization for Operation and Maintenance					
(1). INDRHI (Equipment, Staff)			○	○	Assigned equipment and staff
(2). Junta de Regantes (Equipment, Staff)			○	○	Assigned equipment and staff
3. Actual Budget or Expenditure for Operation and Maintenance of the project Facilities					
(1). INDRHI (Equipment, Staff)			○	○	Allocated budget
(2). Junta de Regantes (Equipment, Staff)			○	○	Collection rate of water charge
4. Actual Water Charge Imposed on Beneficiaries			○	○	Calculation of water charge
5. Maintenance Method			○	○	Functioning of facilities

Items	Construction Stage		After Completion		Monitoring Indicators
	First Half	Second Half	5th Yesr	10th Year	
VI. Benefits Derived From the Project					
1. Direct Benefits by Year					
(1). Annual Agricultural Production (Harvested Area, Unit Yield)			○	○	Harvested area Unit yield
(2). Decrease of Inundated Area			○	○	Damages by inundations
2. Indirect Effects (Specify)			○	○	
VII. Beneficiaries of the Project					
(1). Actual Irrigated Area (ha)			○	○	Irrigated area
(2). No. of Farmers Benefited by Irrigation System (Settlers, Private Farmers)			○	○	Settlers Private farmers
(3). Reallocation of Farmlands (Area, Families)			○	○	Reallocated farmland
VIII Environmental Impact Assessment					
1. Increase in dosage of agrochemicals according with expansion of cultivated area			○	○	Contamination of water quality

CHAPTER 8: ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

CHAPTER 8: ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

8.1 THE TERMS OF EIA

8.1.1 Evaluation Conditions

Environmental impact assessment (EIA) is usually carried out on projects that entail the following works:

(1) Rehabilitation of existing irrigation/drainage canals and farm roads
(2) Construction of a weir and improvement of the irrigation system
(3) Construction of a drainage system

8.1.2 Areas Affected by the Project

The project will affect areas located both outside and inside the project area. Figure 8.1.2 outlines these areas. The sites outside of the project area are located in the downstream area of the Yuna River, the Barracote River, and the Samana Bay, where drainage water from the project area flows into.

Name of Range	Relation between Range and Project	Relative Population & Area
Project area	Farmer : Health by Agrochemicals	Resident : 16,692 (1994)*1
Downstream Yuna River	Drinking Water Source & Land Use : Paddy fields Natural Conservation : Mangrove forest	Resident : 7,454 (1981)*2 Las Coles : 5,886 Trujillo de Yuna : 1,568
Barracote River	Natural Conservation : Mangrove forest	Total area of Mangrove : 97 km^2
Samana Bay	Fisheries (shrimp, etc.) Torism / Recreation : National Park	Fishermen : 1,539 (1980)*2 Main job : 1,118 Second job : 421 Tourists : 5,000 / year *2

Source :
*1 Village Survey (JICA, 1995)
*2 PLAN DE USO Y GESTION DEL PARQUE NACIONAL LOS HAITISES Y AREAS PERFERICAS

8.2 ENVIRONMENTAL IMPACT ASSESSMENT

The results of the environmental impact assessment are laid out in Table 8.2.1. The checklist used was made based on the guidelines of JICA on environmental considerations.

8.2.1 Impact on Social Environment

(1) Society

Impact on Population:

Even though development of new agricultural lands (paddy fields) would raise the migration rate in the area, it would not bring about a drastic increase in population or change in population composition. Although Haitians have settled in the neighboring areas, they have assimilated to the ways of the locals and hence are not likely to cause any conflict among tribal minorities that would later hamper the progress of the project.

Impact on the Economic Activities of the Residents:

The project will provide the residents with jobs and therefore stimulate the economy in the area. The economic conditions of the area will be further revitalized with improved agricultural techniques and the production of good quality produce through the installation and construction of infrastructure that are useful to agriculture, e.g., farm roads.

Impact on Customs and Traditions:

INDRHI should carefully regulate water use as there are no laws or ordinances pertaining to the use of water at present. As there are also no laws or ordinances restricting fishing activities or riparian rights, the preservation of the water quality of water areas (Samana Bay) used for multiple purposes must be given careful consideration.

(2) Impact on public health and sanitation

Increase in Agricultural Chemical Use and Contamination of Water Quality:

Water contamination may result from increase in total agricultural chemical application as paddy field areas are expanded. The residents should be told of the right amount of agricultural chemicals to use, especially during aerial spraying activities. It is also important to formulate application limits to reduce the residual toxicity of agricultural chemicals.

Increase in Domestic Waste:

At present, 90% of the residents dig their own pit latrines within their premises. The estimated increase in flush toilets in the near future is forecast to bring about an increase in domestic waste. The residents should be taught the proper usage of flush toilets.

(3) Impact on cultural and historical remains

A study on the impacts of the project on the National Park "Los Haitises", which is

adjacent to the project area, should be carried out.

8.2.2 Impact on Natural Environment

(1) Impact on important or indigenous flora and fauna:

No area within the project area is covered by the Ramsar Treaty or the Washington Treaty. There are also no development restricted areas within the project area. The study should however conduct caution with regard to wetlands that are the habitats of snapping turtles and landing areas of migratory birds.

(2) Impact on land and soil quality

Soil Erosion and Ground Subsidence:

Although soil erosion problems do not prevail in the project area because of thick vegetation, special counternneasures for soil erosion should be taken as construction works might cause them.
To avoid soil contamination, the residents should be told not to use agricultural chemicals with high residual tendencies. There is, however, a small possibility that grounds composed of peat soils will cave in as a consequence of the installation of irrigation canals.

(3) Impact on hydrology and water quality

Hydrology:

The construction of irrigation facilities will only have a slight impact on river flow and water level. For the formulation of the flood control and water use plans, the river downstream flow velocity and the amount of water used for intake should be taken into consideration. People monitoring river flow and the water users should regulate the intake amount.

According to the 1986 report on the agricultural development study implemented in the Aguacate and Guajabo regions, the downstream flow velocity of Yuna River was estimated to flood the El Limon survey station once every 5 years, as shown in Figure 8.2.1, at a maximum discharge of 650m³/sec, with an inflow load to Pajabo River of 65m³/sec. The volume of water to be planned for discharge from Pajabo River to Yuna River should therefore be in accordance with the river plan to avoid any impediments.

Water Quality:

The implementation of the project would extend paddy field acreage, which in turn would result in higher agricultural chemical and fertilizer dosage and consequently water contamination. River water is used for drinking and paddy irrigation in downstream areas where a mangrove forest and the Samana bay are located. The mangrove forest is enclosed within the National Park "Los Haitises". where development and felling activities are restricted. A shrimp breeding area also exists

within the forest. It is feared the contamination of river water by drainage from the project area will adversely impact the ecological system of Samana Bay.

As previously mentioned, a farming plan that entails the minimum use of agricultural chemicals and fertilizers will only have a slight effect on the environment.

(4) Impact on natural landscape and underground resources

The water quality of the picturesque Samana Bay is going to deteriorate as a result of the implementation of the project. An increase in agricultural chemical application may ruin the scenery and drive tourists away. The residents should be made aware and taught of the proper disposal of waste and excreta.

8.3 ASSESSMENT OF THE IMPACTS OF AGRICULTURAL CHEMICALS

The government of the Dominican Republic is quite apprehensive about the impacts of agricultural chemical utilization on the environment. Therefore, Environmental Impact Assessment on agricultural chemical use was carried out.

8.3.1 Movement of Agrochemicals in the Environment

Agricultural chemicals and fertilizers are used to kill crop damaging pests and to remove weeds. The majority of the amount released gets absorbed by the soil while the remaining amount diffuses into the air in the form of a fine mist. The diffusion of agricultural chemicals or fertilizers sprayed is more widespread because it is carried along with the air currents.

These chemicals are also partly discharged into rivers, marshes and swamps. The gaseous particles that have reached the troposphere fall to the ground together with rain which is then adsorped by the crops and the soil. During rainy days these chemicals permeate into the ground and enter the drainage canals which are connected to the rivers, bay and the sea. Figure 8.3.1 illustrates agrochemical behavior in the environment.

8.3.2 Agricultural Chemical Runoff Ratio from Farms

Agricultural chemical runoff ratio from farmlands varies according to the chemical properties of the products used, topography, soil characteristics, and climate. Existing runoff data were compiled and are shown in Table8.3.1. The runoff ratio of arganic chloride sprayed on stems and leaves to kill insects is 1% of the sprayed amount. The runoff ratio of wettable powder is estimated to amount to 2 - 5% of the applied amount. The runoff ratio fluctuates depending on the gradient of the field and the circulation rate of water. Unless heavy rain falls right after spraying, the runoff ratio of most agricultural chemicals rarely exceeds 0.5%.

A large portion of agricultural chemicals runoffs if heavy rain falls right after spraying. The amount drained if more than 10mm rainfall occurs within 2 weeks after spraying is believed to exceed 50% of the total runoff load. The average runoff ratio of a large number of agricultural chemicals amounts to 1 - 2%, and exceeds 2% during heavy rains or typhoons.

Runoff ratio is also believed to be high if rain falls within a short period after spraying.

Moreover, agricultural chemicals with a solubility of 10mg/liter dissolve in surface water of which the majority flows into rivers. It is quite difficult to reduce runoff to prevent erosion. Insoluble and highly adsorptive agrochemicals adhere to soil particles and suspended matter in water and flow into the river. Their runoff can be controlled through erosion prevention measures.

The runoff ratio of agrochemicals used in farmlands and uplands in the United States was measured and is shown in Table 8.3.1. Agricultural chemical runoff ratio was observed to be higher on bare grounds than on uplands cultivated with crops or covered with weeds. Agrochemical runoff ratio was also observed to be usually higher in paddy fields than in farmlands.

Agrochemical solubility significantly influences runoff into the water systems; highly soluble agrochemicals are more likely to have a higher runoff ratio.

Agrochemicals sprayed onto paddy fields immediately fall onto the surface water, and the runoff ratio is generally higher than on farmlands. In the study area, a large part of the agrochemicals are applied in paddy fields. Conclusively, the runoff ratio to the water systems is considerably higher than the runoff ratio from other areas where farmland agriculture predominates.

The ratio of herbicides discharged from paddy fields to rivers in Japan ranges from 1-6% as shown in Table8.3.2. When spraying was carried out, the concentration of agricultural chemicals in the river was measured to be very high.

8.3.3 Impact of Agricultural Chemical Use on the Environment (Survey)

(1) Survey method

a. Survey Items

Measure the concentration of agricultural chemicals generally used in the study area that flows into Yuna River.

b. Survey Period

The survey will be carried out any day after application.

c. Survey Point

The agricultural chemicals used in the study area are discharged into Yuna River through the drainage canals within the area. The survey area will be station 8 shown in Figure 3.14.1.

d. Survey Method

The survey shall be carried out as follows:

- Establish the amount of agricultural chemical to be sprayed on paddy fields

- Establish the runoff ratio at 5% based on existing data and documents
- Calculate the concentration of the applied chemical in the survey station using the values established in a. and b.

(2) Survey results

The results of the survey are shown in Table8.3.3.

(3) Evaluation

It is commonly reported that agro-chemicals for cropping are overdosed in the Study area. Nevertheless, the water sampling conducted during the field survey at designated sites of the Study area together with its laboratory analysis has disclosed that the use of agro-chemicals in the area is assessed to have little impact on river quality, because the concentration of these agro-chemicals within sampled water was extremely low, although it is worth while to indicate that the timing of sampling was not suited (the sampling was conducted in February in which the cropping of paddy became the lowest level throughout the year, and the application of agro-chemicals becomes less in comparison with other months of the year accordingly).
The use of agricultural chemicals is assessed to have very little impact on river water quality as the concentration measured at the survey station was extremely low.

The survey result is also lower than the guidelines of the World Bank for drinking water , to protect public health, and therefore is not a problem.

There is a need to consider the weather conditions that prevail after the time of spraying as, as previously mentioned, more than 10mm of rain within 2 weeks of spraying can bring about a 50% runoff ratio.

The use of agricultural chemicals without proper guidance could either kill or maim human beings. Therefore, farmers and their families should be given proper guidance and education with regard to the handling and use of these chemicals. To effectively do so, the low rate of literacy in the area must be taken into account in deciding which manner of teaching or guidance is to be implemented.

Since measures for the eradication of contamination by the use of agrochemicals will be applied at the pollution source , restrictions in the sales and use of these chemicals should be enforced along with monitoring activities.