3.7.2 Agricultural Credit

In August of 1996 the Government launched a program to provide credit to the agricultural sector. The banking system is supervised by the Superintendence of Banks, The Agricultural Bank (IDECOOP) , whose funding comes mainly from budgetary allocations from the Government, the Commercial Bank, Agro-processing firms, money lenders and specialized Non-profit Organizations

The Agricultural Bank is the credit institution with the most presence in the Study area. It has bank offices in each of the main cities in the provinces of Azua, Barahona, Bahoruco and San Juan. In 1996, the total number of bank loan, total amount and coverage area was 1,114, DR$ 43.4 million and 4,456 ha, respectively, in the Study area. The interest rate of the Agricultural Bank is 14% per year. The Bank mostly finances the loan for the farm inputs, and the varieties to be financed by the Bank are limited such as rice and red-bean in San Juan Province, plantain and coffee in Azua Province, plantain, coffee and sorghum in Barahona Province. The percentage of the farmers who got the bank loan is so low, it is estimated around only 2 % of the total farmers in the Study area. Most of the farmers who got the bank loan are the beneficiaries under the migrant program by SEA. The reasons of difficulty of access to the bank loan are as follows; i) Total loan amount of the Agricultural Bank is small, and so limited, ii) Farmers do not have mortgage for the loan, iii) Application procedure for the loan is so complicated, iv) There is not the group loan system. Thus the farmers are unavoidably financed by the money lenders The interest rate charged for these money lenders is high, averaging 20% a month. In the Study area non-government organizations that allocate funds to small farmers operate. The interest rate for those type of loans ranges from 18% to 36% annually.

3.7.3 Seeds Multiplication

In the Study area, there are two seed multiplication organizations: the private association of farmers of San Juan de la Maguana (APASJM) and CIAZA. APASJM is located in San Juan irrigation zone and has been multiplying seeds of bean and rice under a contract agreement with SEA. CIAZA has been multiplying seeds and seedlings on a small scale. The objective seeds and seedlings are pumpkin, okra and red bean for seeds and plantain, banana, cassava, sweet potato for seedlings. SEA often makes arrangements with some farmers to produce bean seeds.

3.7.4 Agricultural Cooperatives

The cooperatives in the Republic of Dominica commenced its operation, after IDECOOP was established in 1963 and then Cooperative Laws (ordinance 125) were enacted in 1964. A principle of the cooperative is basically same as the conception of the International Cooperative Affiliation. The cooperative is non-profit organization, which is normally constituted with more than 15 members.

Main duties of IDECOOP are to facilitate cooperative movement, to promote education activities related to cooperatives, to provide the legal services and to render technical, financial and managerial supports toward the cooperative operation. Activities of IDECOOP were depressed in 1970s and 1980s due to lack of management and financial control capabilities of cooperative leaders, and are being further discouraged because of the short of competent staff and budget at present. Despite the fact that a loan service

business is one of the main functions of IDECOOP, the amount of DR$ 48.1 million remains defaulted at the end of 1998.

There exist about one thousand cooperatives in the Study Area, among which 200 numbers count for agricultural cooperatives, and the remaining are for cooperatives of consumers, transportation, etc. According to the estimated numbers of agricultural cooperatives members of about 7,000 households, a participating rate to the agriculture cooperative in the Study Area is as remarkably low as approximately 10%.

Main activities of most agriculture cooperatives are the credit (savings, loan) business under the guarantee of the Government. Only limited numbers of agriculture cooperatives consisting mainly of rice and red beans cultivators in San Juan province are operating cooperative collection and delivery of crop production, cooporative purchase and processing businesses. Those cooperatives are relatively active in their business. In Azua province, there exist approximately 40 agriculture cooperatives consisting mainly of tomato and plantain cultivators and COOFEPRACO which is a federation of cooperatives in the province. COOFEPRACO represents the cooperatives as a receiver of the Government loans, and further it executes the contract with a tomato processing firm for contract basis cultivation of tomato, as well as negotiates tomato prices with Ministry of Agriculture.

Agriculture cooperatives are commonly composed of farmers who produce identical crops or lives in the proximity each other. Most of cooperatives are weak in every aspect of organization operation and delicate by the following reasons; (1) the members are so limited as less than 20, (2) since the size is small, the cooperative is not capable of carrying out cooperative collection and delivery of crops, cooperative purchase businesses, which are the most important roles of cooperative, (3) managing staff of cooperatives are insufficient in capacity of organization management and financial control and (4) the cooperative members inclusive of managing staff are lacking of a sense of solidarity as a union of cooperative members and recognition of objectives of cooperative, which have been induced from the insufficient education and training services to be rendered from the Government.

Under those weakened organizational circumstances, and due to the curtailed supporting business of IDECOOP, agriculture cooperative credit (saving and loan) services in most of agriculture cooperatives are depressing, and then the present activities are varying from the original concept of cooperative. Main activities of most of cooperatives at present are the arrangement of construction request of social infrastructure/irrigation facilities, and lobby activities to the Government for obtaining of free charge seeds/free charge land preparation services.

It is considered that the following measures will be required to activate agriculture cooperatives; (1) to raise the capacity of managing staff of cooperatives through education and training (especially for managing and financial aspects), (2) to establish new federations at the province (Barahona and Baoruco districts) level, which are given bargaining power similar to Azua Federation (COOFEPROCA), (3) to organize the powerful association to unify the provincial level federations in the Yaquedelsur river basin, (4) to possess the bargaining power toward marketing business encompassing cooperative collection and delivery of crops, cooperative purchase businesses in addition to the present credit (saving,

loan) business, and (5) to improve the participation rate to cooperative especially in paying attention to farmers cultivating main crops in each province.

In the case of the land Reform Settlement, the Agrarian Reform Institute (IAD) requests land beneficiaries to belong to production cooperatives. This mechanism is used to channel credit, technical assistant and market outlet. Usually an extension agent acts as manager and coordinates actions with a social worker and a training coordinator. There exist 15 non-government organizations in the Study area. These work mainly on strengthening the institutional capability of farmer organizations and rural organizations especially women and youth organizations. SEA provides some assistance to farmers through the Department of Rural Organization. However, presence in the Study area is limited to working with extension agents in training activities to strengthen institutional capabilities.

3.8 Environmental Aspects

3.8.1 Environmental Conditions and Problems in the Study Area

(1) Present Condition of Forest and Deforestation

According to the results of FAO's survey and estimation, the forest area in the country has been always decreasing. In the Study area, the forest areas mainly consist of the coniferous forest and dry forest whose areas are 840 km^2 (12%) and 1,750 km^2 (25%) correspondingly. By 1960s, tree cutting on commercial basis has caused reduction of forest. Tree cutting on the commercial basis was prohibited by the Government laws in 1968, and since then, reduction of forest has been caused by shifting cultivation that small farmers conduct at 3 to 5-year intervals, as mentioned in Section 3.3.1. Forest cutting in the upstream basins of the Las Cuevas and the Grande rivers, which are tributaries of San Juan and Yaque del sur river, causes the soil erosion as well as soil degradation as detailed below. Reforestation projects are implemented on a small scale at present, and besides reforestation it is further required to prohibit the shifting cultivation, and to promote sedentary agricultural cultivation which enables to practice sustainable agriculture for securing the soil conservation.

(2) Erosion and Degradation of Soil (including soil salinization)

Erosion and degradation of soil seriously affect agricultural productions and sedimentation in reservoirs. The measurement data on sediment inflows to Sabaneta dam and Sabana Yegua dam show the sediment runoffs of 2,000 m^3/year/km^2 (2 mm/year) and 2,600 m^3/year/km^2 (2.6 mm/year) in San Juan river basin and Yaque del sur river basin, respectively. According to those data, a large amount of soil is washed out. The main causes of the soil erosion are deforestation and also the farming systems without proper soil management. In the area where irrigation and drainage are improperly practiced, a problem of soil salinization is observed.

(3) Present Condition of Biodiversity and Wildlife and their Loss

Together with the natural environmental degradation such as deforestation, the level of biodiversity and the number of wildlife have been decreasing because of human activities. Protection of fauna and flora principally depends on the existence of national parks and

reserve areas. In the Study area, there are 6 national parks. Precious wildlife inhabit in the Cabral-Rincon lake national park. Rincon lake functions as a flood retarding basin. After completion of Sabana Yegua dam, lake water levels in the rainy seasons (September through December) in 1978-1990 after completion of dam have drawn down much more than those in 1968-1990 before dam completion, although the dry year has continued in those years. Due to a lack of the basic data on environmentak conditions of wildlife in the said national park, such as water quality, stored volume of water, water levels, etc, the basic preservation plan of wildlife remains unprepared. It is urgently required to set up the institutional arrangement for data collection.

(4) Environmental Pollution (especially water pollution)

Water pollution by agricultural chemicals, such as fertilizer, pesticide and herbicide, in both surface and ground water, is pointed out. The critical areas in the Study area are considered to be Azua where intensive cultivation of tomato and melon are observed, and in the San Juan area where paddy fields are distributed. But, at present the pollution level is not clearly understood.

(5) Comparatively Minor Environmental Problems

The environmental problems in regional level, and some problems strongly related to agricultural projects are:

(a) Health and Water Born Diseases

As a result of agricultural projects, as water areas increase, cases of the water born diseases may increase, such as diarrhea, malaria, typhus and dengue fever. In the Study area, there are many cases of hospitalization because of acute diarrhea and typhus.

(b) Water Rights

At present, many cases of water use without water rights are observed in the Study area. Concerning agricultural projects, some problems may occur concerning water rights in an area by the change of the useful water volume.

(c) Resettlement

In the Study area, some cases of resettlement were observed in the construction of Sabana Yegua Dam. In other cases, resettlement to a newly irrigated area and the resettlement projects by the IAD are observed.

(d) Gender

Especially in the rural areas, sexual inequality is observed. For example, women have few chances of participation in social activities.

3.8.2 Organization in Charge of Environmental Management and Relevant Laws/Regulations

(1) Organizations

There are no integrated governmental organizations to handle the environmental issues, but several relevant organizations exist. The principal organizations are: the Department of Environment, National Planning Office (ONAPLAN), Sub-secretariat of Natural Resources (SURENA, SEA), General Direction of Forest (FORESTA), National Commission of Forest Technology (CONATEF), National Direction of Parks (PARQUE), Office of Watershed Management, INDRHI, and other NGOs.

(2) Relevant Laws and Regulations

The proposal of the "Law of Protection and Environmental Quality " is in the process of issue in the parliament, so at the present there is no integrated law concerning the environment. So far laws and regulations relating to the environment are: Law 5856 (April 2, 1962), Law 5914 (May 22, 1962), Law 627 (May 28, 1967), Law 123 (May 19, 1972), Law 67 (Nov. 8, 1974), Law 632 (May 22, 1977), Law 295 (August 28, 1985)

3.8.3 Existing Environmental Programs in the Study Area

In the Study area, several projects and programs relating to environmental aspects are carried out by several organizations. The principal projects and programs are: National Plan Quisquella Verde, PRODAS (Agricultural Development Program in San Juan de la Maguana), Reforestation Project in Rio Las Cuevas, Project Rational Management of Dry Forest, Management of National Parks, and some programs by NGOs.

3.9 Present Overall Water Balance in the Yaque del Sur River Basin

3.9.1 General

In the Study area, the surface water, particularly the river waters, plays a great role in the water supply. The main source of the river water is rainfall, but the runoff of the Yaque del Sur River is greatly controlled by artificial factors which are: i) operation of the two dams whose catchments occupying nearly half of the total river basin, ii) large irrigation area which retards the runoff, iii) irrigation operation including trans-basin water distribution, etc.

3.9.2 Water Right

Water right is set for any forms of water in the country, not only for surface water such as rivers, lakes, springs, but also for groundwater.

INDRHI registers and entitles the water right to each user every year by the canal system. In San Juan and Azua Irrigation District, water users' associations have been organized and they manage; i) operation and maintenance of facilities, ii) water distribution, iii) setting and collection of water charges.

The number of users and irrigation areas of the water users' associations are summarized below:

Zone	No. of users	Area (ha)	Unit Charge (DR$)
San Juan	3,404	13,045	190.8 (381.6)*
Azua	4,638	7,555	287.0
Total	8,042	20,600	

Remarks;(*); Upland crops (Rice)
Source: Transferencia de los Distritos de Riego a las Juntas de Regantes, 1995, INDRHI

Irrigation water users who do not belong to the water users' associations have to register themselves at each Irrigation District. The number of registered water users and their areas are summarized below:

Zone	No. of users	Area (ha)	Unit Charge (DR$)
San Juan	4,634	10,174	102.04
Azua	8,232	17,478	201.97
Barahona	8,340	10,441	159.62
Neiba	5,585	8,866	109.75
Total	26,791	46,960	

Source: Listado de Usuarios por Canales con Valor por Tarifa, 1997/98", INDRHI

The water charges are determined on the basis of necessary operation and maintenance costs that are revised every year, and paid in advance for the coming cropping seasons. It is noted that the charge is not based on the volume but only for the right to receive the waters from the irrigation canals. Accordingly, the collection rate of the charge is very low at 10 to 20 % as reported.

3.9.3 Potential Water Resources

(1) Surface Water

In the course of the evaluation, the Study area was divided into three blocks in which water supplies mostly depend on the Yaque del Sur River and its tributaries. The blocks are: i) San Juan Block, ii) Azua Block, and iii) Barahona/Neiba Block. The present water distribution system in the Study area is illustrated in Figure 11.

(a) San Juan Block

The average annual runoff at each intake point is summarized below:

Name of Water Source	Location	Runoff (MCM/year)	Catchment Area (km^2)
San Juan	Sabaneta Dam	263	464
Mijo	Mijo HW	136	161
Los Baos	Vallejuelo HW	17	335
San Juan	Sabana Alta (End of the block)	432	1,915

Source: Actual records observed by INDRHI (1981 - 1994)

(b) Azua Block

Azua Block has two main water resources, i.e., the Yaque del Sur River or Sabana Yegua Dam, and the residual runoff from the San Juan Block.

The volume of the runoff which is estimated on the basis of actual observation records (1981 - 1994) is summarized below:

Name of Water Source	Location	Runoff (MCM/year)	Catchment Area (km^2)
San Juan	Sabana Alta	432	1,915
Yaque del Sur	Sabana Yegua Dam	608	1,676
Yaque del Sur	Los Guiros (end of the block)	813	3,885

Source: Estimated based on the actual records observed by INDRHI (1981 - 1994)

(c) Barahona/Neiba Block

Located on the downmost reach of the Yaque del Sur River, Barahona Block receives only the remaining river waters at the end of Azua Block (Los Guiros) and runoff from the residual catchments.

The volume of the runoff which is estimated based on the actual observation records (1981 - 1994) is summarized as follows:

Name of Water Source	Location	Runoff (MCM/year)	Catchment Area (km^2)
Yaque del Sur	Los Guiros (end of the block)	813	3,885
Yaque del Sur	Conuquito (Santana HW)	774	4,587
Yaque del Sur	Palo Alto (end of the block)	323	4,636

Source: Actual records observed by INDRHI (1981 - 1994)

(2) Groundwater

As mentioned in the Sub-section 3.2.3, the Study area belongs to four "hydro-geological zones": i) San Juan Valley, ii) Neiba Mountain Range, iii) Neiba Valley, and iv) Azua Valley.

According to previous studies, the groundwater potential is estimated at 50 MCM/year for San Juan Valley, 100 to 120 MCM/year for Neiba Valley and Neiba Mountain Range, and 75 MCM/year for Azua Valley.

3.9.4 Operation Rules of Sabaneta Dam and Sabana Yegua Dam

(1) Organization

Operation of the dams in the Dominican Republic is being undertaken according to the agreement between INDRHI and the Dominican Electric Corporation (CDE)[1].

Three administrative bodies were established for the dam operation: i) the Council on the Control of Dam Basins, the highest level organization to establish general policy, ii) the Committee for the Operation of Dam Basins, a body independent of the others, for the purpose of direct execution of the policies established by the Council of Control and iii) Emergency Dam Operation Committee[2] (COEE) which determine the operation during emergency periods such as hurricanes and abnormal runoff from the catchment.

1 : Convenio de Coordinacion Interinstitucional entre El Instituto Nacional de Recursos Hidraulicos y La Corporacion Dominicana de Electricidad.

2 : Comité de Operación de Embalses en Emergencia.

(2) Ordinary Operation

The basic understandings of the dam operation are:

- To let the water level reach the maximum operation level by the beginning of the cropping season (November),
- The irrigation areas of the year are determined and adjusted according to the water levels of the reservoirs before the planting,
- In case the water reserved in the storage becomes in short, the said Committee determines regulated operation of reduced discharge and/or hours.

(3) Emergency Operation

The operation rule for the emergency period is given in "Instruction of Operation in Emergency[3]" which was prepared in 1994 for the seven (7) national-level dams, by the Emergency Dam Operation Committee (COEE).

The maximum operation levels of Sabaneta Dam and Sabana Yegua Dam are given below:

(a) Sabaneta Dam

January to May		643.00 above the mean sea level (amsl), constant
June to July	abasement	Linear variation from 643.00 to 636.00
August to September	critical	636.00 amsl, constant
October to November	recovering	Linear variation to 636.00 to 643.00 amsl
December		643.00 amsl, constant

These maximum operation levels were revised in 1998 after completion of the improvement works of the emergency spillway. The level is set at a constant level of 643-m amsl through the year at present.

(b) Sabana Yegua Dam

January to May		396.40 above the mean sea level (amsl), constant
June to July	abasement	Linear variation from 396.40 to 386.00 amsl
August to September	critical	386.00 amsl, constant
October to November	recovering	Linear variation to 386.00 to 396.40 amsl
December		396.40 amsl, constant

3.9.5 Present Sectorial Water Use in the Yaque del Sur River Basin

(1) Irrigation Sector

Present water use or demands for irrigated agriculture in the Study area was estimated on the basis of the actual irrigation conditions, such as area, irrigation efficiency, effective rainfall, infiltration rate, cropping patterns, and so on. The irrigation water demands by block are summarized below:

[3] : Instructivo de Operación durante Emergencias.

(a) San Juan Block

Irrigation System	Total Area (ha)	Irrigated Area (latest 3-5 years) (ha)				Gross Irrigation Demand (MCM)		
		Nov - Apr	May - Oct	Perennial	Total	Nov -Apr	May - Oct	Total
Jose Joaquin Puello	10,986	3,840	2,391	1,240	7,471	50.6	59.2	109.8
San Juan	5,526	406	769	-	1,175	33.0	71.2	104.2
Hato del Padre	2,059	1,018	1,073	88	2,179	11.4	23.1	34.5
Mijo	2,390	1,278	1,945	-	3,223	22.0	43.7	65.7
Guanito San Juan	1,000	406	769	-	1,175	9.5	18.7	28.2
Others	2,343	1,390	1,915	56	3,361	16.6	36.9	53.5
Total	24,304	8,338	8,862	1,384	18,584	143.1	252.8	395.9

(b) Azua Block

Irrigation System	Total Area (ha)	Irrigated Area (latest 3-5 years) (ha)				Gross Irrigation Demand (MCM)		
		Nov - Apr	May - Oct	Perennial	Total	Nov -Apr	May - Oct	Total
Ysura Conveyance C	1,100	372	238	378	988	12.0	9.2	21.2
Ysura Canal (Tabora)	10,007	4,965	2,180	3,305	10,450	154.2	102.4	256.6
Others (A1)	2,366	796	512	812	2,120	25.8	19.9	45.6
Total	11,198	6,133	2,930	4,495	13,558	192.0	131.5	323.4

(c) Barahona/Neiba Block

Irrigation System	Total Area (ha)	Irrigated Area (latest 3-5 years) (ha)				Gross Irrigation Demand (MCM)		
		Nov - Apr	May - Oct	Perennial	Total	Nov -Apr	May - Oct	Total
Los Guiros - Santana HW (B1)	2,791	130	160	2,440	2,730	54.9	54.5	109.4
Santana System (B2)	12,000			7,660	7,660	222.9	227.7	450.6
Santana - Tomate (B3)	2,853	145	160	2,495	2,800	56.3	55.4	111.7
Tomate (B4)	371	21	25	330	376	6.9	6.8	13.7
Tomate - Palo Alto (B5)	1,565	28	33	1,120	1,181	24.6	24.8	49.4
Palo Alto - (B6)	2,665	90	105	2,200	2,395	46.9	46.6	93.4
Total	22,245	414	483	16,245	17,142	412.5	415.3	828.2

Consequently, the total irrigation water demand in the Study area amounts to **1,548 MCM/year.**

(2) Municipal Water

According to the inventory of INAPA, total actual discharge of the drinking water supply systems in the basin is estimated at 17 MCM/year from the surface water and 21 MCM/year from the groundwater.

(3) River Maintenance Flow

There is no regulation on "river maintenance flow" in the Dominican Republic. However, the river maintenance flow or demand can be estimated as "emergency demand for domestic use", "environmental maintenance demand", and "preventive flow against salt water intrusion".

Taking into account the population in the Study area, which is more or less 100,000 to 200,000 for each block (San Juan, Azua, Barahona, and Neiba), and minimum requirements (assumed at 50 liters/persons/day), the emergency requirements in discharge are less than 0.2 m^3/sec.

In order to provide the required flow for preventing salt intrusion near the

confluence, maintenance of the wild life and species, and so on, one cubic meter per second (1.0 m^3/sec) which is equivalent to 31.5 MCM/year is to be secured on the downstream of Palo Alto.

On the upper reach of Palo Alto, 0.5 m^3/sec is considered the minimum maintenance flow, which is presumably covered by the return flow and base-flow of the Yaque del Sur River through the year.

3.9.6 Present Overall Water Balance in the River Basin

(1) General

In the course of the Study, quantitative assessment of water resources was done on the surface water and the groundwater. Since the surface water is utilized over the vast Study areas, **an inter-basin water balance simulation** was carried out focusing on: i) available water at major intake points, ii) operation rules or actual practices on water distribution, iii) return flow from the irrigated area, iv) runoff from the residual catchments, and v) irrigation water requirements at each irrigation area.

The simulation primarily used the actual records, and then coefficients and factors of a runoff model were adjusted by comparing the estimated figures and the actual records. The flow chart of the simulation is given in Figure 12.

(2) Settings and Assumptions by Block

The Study area was divided into three blocks according to the administration boundaries of the Irrigation Districts of INDRHI. Settings and assumptions for the simulation are described by block as follows:

(a) San Juan Block

Hydrological checkpoints were set for the locations at which actual runoff records are available. The water budget (in-flow and out-flow) of Sabaneta Dam is the primary and most important information because the dam is the starting point of the block.

(b) Azua Block

The starting point of this block is Sabana Alta which is located at the end of the San Juan River and is facilitated with a rivergauge. The water budget (in-flow and out-flow) of Sabana Yegua Dam plays an important role in the block as the other starting point of the block.

(c) Barahona and Neiba Block

Los Guiros is the starting point of the block. Conuquito (D6c) is a hydrological station located right upstream the Santana headworks. Palo Alto (D8a) provides the data for the final checking of the simulated and actual runoff at the end of the block.

(3) Basin Water Balance Model

The water balance model contains two determinants on the simulated runoff. They are i) artificial factors such as dam operation, gate operation, etc., and ii) uncontrolled or natural runoff. However, it is quite difficult to simulate such artificial operations by formula or models. In this simulation (under present condition), artificial factors such as the water distribution are not considered. Only the coefficients of the hydrological runoff model were adjusted to fit the actual runoff at the checkpoints. At this stage of the Study, the simulation model has been prepared focusing on representativeness of the base flow and the annual runoff volume.

The hydrographs of the simulated runoff and the actual runoff at representative checkpoints are compared in Figure 13.

(4) Present Overall Water Balance

(a) Inter-Basin Water Balance for Irrigation

Table 6 to Table 8 show the results of the water balance simulations by block. Available water at each intake point, irrigation water extraction, return flow from the upper irrigation areas, runoff from the residual catchments are summarized in volume by year (total of monthly volume).

Table 9 to Table 11 show the sufficiency rate of the irrigation water supply by block, irrigation system and season. The following points are indicated by the simulation results:

- Paddy cultivation in San Juan Block meets water shortage at the intake points in the present conditions (low irrigation efficiency, planted areas).
- Vallejuelo Irrigation System has planted areas too large compared with the small amount of available water
- Guanito San Juan system is located in a good situation receiving constant return flow from the José Joaquin Puello irrigation area
- Azua Irrigation System receives sufficient irrigation water supply at the intake points (Villarpando) in the present conditions
- In Barahona, only Santana Irrigation System and the areas downstream of Palo Alto meet water shortage in the present conditions. Particularly, in the Santana system, the sufficient rate is about 70 % even though the area takes 50% of the available water from the Yaque del Sur.

(b) Groundwater

The groundwater potential in the Study area is summarized below:

Block	Groundwater Potential (MCM)	Remarks
San Juan	50	the whole valley
Azua (Tabara)	75 (50)	50 for excluding recharge from irrigation canal.
Azua (Extension)	6-8 (4-6)	4-6 for excluding recharge from irrigation canal.
Neiba-Galvan	50	
Others in the Study area	70	Sierra de Neiba and others
Total	250	

Note: refer to 3.9.3 (2) "Groundwater"

The possibility of groundwater exploitation at certain points is to be estimated on the basis of hydro-geological investigations. However, it can be said that the groundwater in the Study area is primarily used for the domestic purpose taking into account the limited overall potential, water quality, high cost of water, and so on.

(c) Water Balance

The total volume of the surface runoff is estimated by the runoff simulation model. The average runoff (1981 - 1994) at Palo Alto is estimated at 1,430 MCM/year if none of the river waters are used on the upstream. Thus the total volume of the potential water resources in the Study area is estimated at 1,680 MCM/year, including groundwater. On the other hand, the total water demand under present conditions is 1,620 MCM/year, consisting of 1,550 MCM/year of irrigation demand, 40 MCM/year of municipal demand, and 30 MCM/year of river maintenance flow.

4. MASTER PLAN STUDY ON INTEGRATED RURAL DEVELOPMENT PROJECT OF THE YAQUE DEL SUR RIVER BASIN

4.1 Basic Approach to the Project

4.1.1 Development Constraints

Main constraints on the integrated rural development in the Study area are summarized below:

Water resources in the Study area are scarce : The climate is semi-arid or arid. The annual rainfall is small, ranging from 500 mm to 1,500 mm. There is a considerable year to year variation in rainfall. Most of the rainfall is concentrated during the rainy season and erratic. River water during the dry season is seriously short in spite of plentiful water in the rainy season.

Inadequate land use management : At present, about 271,000 ha are used as agricultural lands. Of these lands, about 200,000 ha are cultivated under the rain-fed conditions or for shifting cultivation. This land use pattern, particularly in the shifting cultivation area of 154,000 ha, causes serious problems from the viewpoint of soil conservation. Because of the shifting cultivation, the conditions of vegetation have been degraded, resulting in the soil erosion and degradation of soil conditions in the area. Particularly, the soil erosion in the area causes sedimentation problems in the Sabaneta and Sabana Yegua dams and in the canal system and furthermore lowering of soil productivity, resulting from the degradation of soil conditions.

Lack of improved irrigation farming : Deterioration of seeds, application of low level of farm inputs, poor irrigation water management, poor farming practices and so forth. As a result, the unit yields of crops and cropping intensity remain low.

Poor agricultural support services : Most of the governmental agricultural support services such as extension, research, seed multiplication and agricultural information are poor because of lack of budgets, trained staff, lack of necessary facilities and equipment for providing services for farmers. Access to credit services in the Study area is also poor.

Deterioration of irrigation facilities and low irrigation efficiency : The existing irrigation facilities are old and deteriorated. Sometime facilities for proper irrigation water delivery are insufficient and malfunction. Moreover, proper irrigation water management has not been performed due to low institutional development of irrigation water management. As a result, irrigation loss, especially canals and field application is seriously large, which has restricted effective use of water resources.

Poor rural infrastructure and small farm size : The Study area is one of the most disadvantaged regions in the county. The ratio of local people to receive such social servicing appears about 10 % lower than that of national level.

Socio-economic problems : The average illiteracy rate is high, being 34%. The average unemployment rate indicates 45% because there are no job opportunities other

than agricultural activities. Farm size of the farmers in the Study area is small, averaging 2.32 ha.

As a result, incomes of the farmers in the Study area are low and their living standard is also low not only based on income level but also the quality of life.

4.1.2 Basic Development Concept

(1) National Policy for Development

In August 1996 the new administration defined the country's social and economic development strategy. The agricultural policy is: (i) promotion of food production and enhancement of the level of production and income level in small farmers, (ii) promotion of trade liberalization and market access, reduction of price controls for domestic agricultural markets, (iii) increase credit access to the agricultural sector, (iv) increase of investment on irrigation facilities and maintenance of the existing irrigation systems, improvement of irrigation system management to water users, improvement of legal and institutional arrangement, (v) promotion of soil conservation and watershed management through agro-forestry industry by small farmers and (vi) promotion of coordination between research and extension systems, promotion of efficient management mechanism of Agricultural Research centers decentralizing their operation and incorporating the private sector and farmers.

(2) Farmer's Desires

The results of the farmers' interview survey on desires for rural integrated development indicated that the expectation that ranked first concentrates on the construction of irrigation facilities, followed by access to subsidized credit, construction of aqueducts, access to subsidized inputs and construction of community facilities.

(3) Basic Development Concept

It is essential that constraints and problems identified should be solved to develop integrated rural development effectively, taking into consideration government development policy and farmer's desires for development. The overall objectives of the Project are: (i) stabilization of farmer's economic situation, (ii) improvement of quality of life of the farmers, (iii) creation of job opportunities and (iv) improvement of social welfare.

(i) Soil conservation through the settlement of sustainable agriculture development in the rainfed areas and reforestation in the Yaque del Sur river basin.

(ii) Increase of agricultural production through the improvement of irrigated agriculture techniques.

(iii) Increase of cropping intensity through improvement of irrigation efficiency and effective use of river water, which will be attained by improvement of irrigation system, establishment and reinforcement of water users' associations (WOUs) and strengthening of river basin management.

(iv) Strengthening of agricultural supporting system for better management of rain-fed and irrigated agricultural system.

(v) Improvement of social infrastructure in the rural area.

(vi) Environmental conservation in and around Rincon Lake.

In the above basic concept, the environmental conservation item will deal with the 200,000 ha of rain-fed area including the shifting cultivation area. For the soil conservation in the Study area, the shifting cultivation area is planned to alter to sedentary rain-fed cultivation in some area and reforestation in the remaining area. In the rain-fed area, particularly in the upland fields, it is intended to increase the farm income through introduction of low-cost farm management with application of organic compost and nitrogen-fixing bacteria, soil conservation farming and introduction of fruit. The low-cost farm management will consist of the maintenance of soil fertility by applying manure of pigeon pea, increasing nitrogen-fixing bacterium and by developing the soil-conservation technique. As for the devastated rain-fed coffee plantation being managed by small-scale farmers, it is planned to conserve soil condition and to increase the farm income of the farm household. The reforestation work is to be carried out through farmers' participatory approach mainly in the upstream basin of the Grande river; a tributary of the Yaque del Sur river, where heavy soil erosion is occurring.

The increase of farm production through improvement of irrigated agriculture techniques will be realized by employing the improved irrigation farming techniques which include application of seeds and nurseries of high yielding varieties, proper control of fertilizing and proper water management at on-farm level.

The present crop intensity of 80% is to be maximized as far as the water resources allow. For this maximization, the following works are intended to be implemented:

(i) Rehabilitation and improvement of existing irrigation facilities, construction of new irrigation system, alteration of water supply system from pumping system to gravity system, construction of night storage ponds, and construction of operation and maintenance roads along the canal system.

(ii) Establishment of WOUs with 3 tiers system and water users' groups at the on-farm level, and management, operation and maintenance of the irrigation system by WOUs.

(iii) Rehabilitation of the Villarpando headworks and proper water distribution through the headworks to the Azua Irrigation District Area and Yaque del Sur - Lago Enriquiquillo Irrigation District Area.

(iv) Realization of effective use of river water including two reservoirs through the establishment of Yaque del Sur Water Management Center, monitoring and evaluation of water distribution at the major check points by installing a telemetering system, and the direct/indirect operation of irrigation system and real-time adjustment of canal discharge based on the monitored and evaluated results mentioned above.

As a part of agricultural support services, a training program is to be first conducted with a main emphasis on the level-up of farming techniques of the extension workers. As for the agricultural research, it is intended to strengthen the CIAZA Research Center located in Azua province , which is one of the research centers operated by the Ministry of

Agriculture. This center does not fully function at present because of shortage in its budget. For this strengthening, it is proposed to re-organize the center by combining the private fund and the government function, to train the researchers, to provide the station with an appropriate number of research instruments and facilities. For the agricultural credit, a pilot project is to be implemented to itroduce a group investment. The seed multiplication is intended to be conducted at the CIAZA Research Station and by the private enterprises to suffice the requirement of improved seeds and nurseries after the project implementation. As for the agricultural cooperatives, it is intended to establish agricultural unions in both Barahona and Baoruco provinces, where there are no federation of agricultural cooperatives at present, to conduct the small-scale credit business both for credit and deposit and to manage the marketing system for agricultural products and farm inputs. In addition, the Yaque del Sur Farmer Marketing Board is to be established in the Study area to control the marketing activities in the whole basin. The existing federation of agricultural cooperative and agricultural cooperatives are to be strengthened under the project. The existing agricultural information system being operated by JAD will also be strengthened under the project.

It is also intended under the project to improve the farmers' living conditions through improvement of fundamental rural infrastructure such as farm roads, drinking water supply system, rural electrification system and communal facilities.

As for the environmental conservation of Rincon Lake, a long term monitoring is to be conducted to collect the periodical data, since there are few basic data for the environment in and around the lake at present.

In order to achieve this purpose, development plans are formulated on seven sectors: (1) agriculture, (2) agricultural supporting service, (3) overall water management, (4) irrigation and drainage, (5) rural infrastructure, (6) environment and (7) water resources development.

4.2 Agriculture Development Plan

4.2.1 General

The agricultural development plan for Yaque del Sur River Basin is set with the main objectives of increasing total agricultural production through improvement of yield of crops and cropping intensity in the Study area. In order to achieve this objective, projects and programs, proper management of land use and introducing appropriate farming practices, including the use of improved crop varieties, and application of adequate level of fertilizer and agricultural chemicals, proper irrigation water management, and appropriate farming technology are carried out.

4.2.2 Land Use Plan

(1) Land Use Pattern

The future land use plan will be established taking into account the land classification, hydrological conditions including irrigation and rainfall, and soil conservation. At present, about 154,000 ha of lands located in steep-sloped area are used as pasture lands or shifting

culture lands, and about 46,000 ha are used for rain-fed cultivation. However, these lands are not properly managed and therefore cause serious soil erosion. In this master plan, therefore, it is proposed to implement the following development programs to promote the reforestation and land use suitable for the steep-sloped area as detailed in Section 4.2.3(2), 4.2.4 and 4.9:

(i) Sustainable agriculture development in the rain-fed cultivation area including the shifting cultivation area.

(ii) Pilot type of reforestation in 720 ha.

(iii) Renewal of coffee trees of which economic useful life has been expired or which have never been properly taken care of, in the total area of 7,200 ha.

Through the implementation of the above items (i) and (ii) in particular, it can be expected that the shifting cultivation area would turn to the sedentary cultivation area. It is estimated that about 26,000 farm households are engaged in the shifting cultivation at present. Based on the above-mentioned technical data, it is expected that these farmers will be engaged in the sedentary cultivation after getting cash income through not only the forestry work but also the proper cultivation of tree crops and upland crops. The farm size of one household engaged in shifting farm is 2 ha. In a long term, it is expected that the settled rain-fed cultivation area would reach 52,000 ha, and remaining 102,000 ha of shifting cultivation area will be utilized as a forest area.

In the irrigated area, the basic development concept is set up with the improvement of the crop intensity through the rehabilitation of the existing irrigation system instead of new land development except 6,540 ha in total composing of the Galvan groundwater development project (540 ha) and the on-going INDRHI project (5,950 ha).

On the basis of the above considerations, land use pattern in the future is shown below.

Land Use	Present/Without Project		Future/With Project	
	Area (ha)	%	Area (ha)	%
Agricultural Lands	271,000	38.1	175,450	24.7
Irrigated Agriculture	71,000		77,450	
Rainfed Agriculture (Exclude shifting agriculture)	46,000		98,000	
Natural Pasture and Shifting cultivation	154,000		0	
Forest Lands	394,000	55.4	489,450	68.8
Dry land Forest	175,000		175,000	
Humid land Forest	84,000		186,000	
Bush and Shrub	135,000		128,450	
Barren Lands	37,000	5.2	37,000	5.2
Wetlands (Drainage problem)	3,000	0.4	3,000	0.4
Water Bodies	4,000	0.6	4,100	0.6
Urban/Village and Other Lands	2,000	0.3	2,000	0.3
TOTAL	711,000	100	711,000	100

4.2.3 Food and Cash Crops Production Improvement Plan

(1) Production Improvement Plan in the Irrigated Lands

(a) Proposed Cropping Pattern

It is not proposed to introduce new crops but the crops which are widely prevailing

in the Study area taking into consideration the existing farmers' experiences and performances, actual conditions of research and extension services to the farmers and the support to the marketing services. Main crops are rice, red beans, plantains, banana, pigeon pea, sugarcane, sweet potato, corn, cassava, coffee, etc. For formulating proposed cropping pattern, special emphasis is placed on the following points:

(i) 120 days improved variety of paddy is introduced instead of 150 days variety in order to minimize the irrigation water requirement.

(ii) 80 days improved variety of pigeon pea is also introduced instead of present 270 days variety in order to minimize the irrigation water requirement and to effectively utilize the rainfall.

(iii) Planting period of tomato for processing is fixed during cool season from beginning of October through March in order to minimize the damages due to pests and diseases.

(iv) Planting period of red bean is also fixed during cool season from beginning of October through March in order to minimize the damages due to pests and diseases.

(v) Repeating cultivation of tomato for processing is prohibited in order to prevent from the damages due to the repeating.

(b) Farming Practices and Anticipated Yields

To attain the target yields of crops, it is necessary to introduce significant improvement of the farming practices. The recommended farming practices are described in Table 12. The target yield of each crop planted in the Study area is set based on the review of available local data, discussion with research and field workers, or international publications related to tropical agriculture. The anticipated yields of major crops with project condition are summarized below:

Crop	Yield without project conditions (ton/ha)	Yield with project conditions (ton/ha)
Rice	3.0	4.5
Red beans	1.1	1.5
Plantain	18	23
Banana	26	36
Sweet potato	13	17
Cassava	9	12
Pigeon peas	1.5	3.0
Corn	2.0	2.8
Sorghum	3.5	4.5
Sugarcane	30	130
Tomato	25	30

(c) Crop Production

Irrigation is essential for crop production in the Study area because of scarcity of rainfall as mentioned previously. The improvement of irrigation efficiency as a result of implementation of the proposed irrigation and drainage projects and Yaque del Sur water management center project will increase availability of irrigation water. It is proposed that future additional available water be used to achieve an increase in the cropping intensity as well as the crop yield in existing irrigated lands, instead of increasing the irrigated lands, following the present cropping pattern taking into consideration the farmers' experienced

practices.

(i) Considering the farmers' intention, annual cropping intensity should be decided based on the distribution program to each irrigation system.

(ii) Following the Government policy, the cropping area of the paddy, which needs high water requirement, remains unchanged.

(iii) For the sugarcane area in the Barahona and Enriquillo irrigation district, sugarcane production is controlled applying the improved farming practices based on the capacity of the existing sugar factory.

(iv) Planting area of the banana remains unchanged according to the market forecast by the Ministry of Agriculture.

The anticipated total production of major crops in the Study area after the full implementation of proposed projects is summarized in Table 13.

(2) Rainfed Agriculture Production Improvement Plan

(a) General

The main objectives of rainfed agriculture improvement plan are: (i) to conserve soils by promoting the change from shifting cultivation to sedentary rainfed farming, (ii) to stabilize and increase agricultural production; and (iii) to improve living condition of families engaged in rainfed agriculture by increasing agricultural product. For this purpose, introducing simple and low-cost farming will pursue the achievement of these objectives. At present, total rainfed lands are 200,000 ha consisting of shifting culture land of 154,000 ha and sedentary rainfed lands of 46,000 including 12,000 coffee farms. As mentioned in section 4.2.2 (1), for future land use, present rainfed lands are planned to become sedentary rainfed land of 98,000 ha of 12,000 ha-coffee farm and 86,000 ha of sedentary rainfed land, and wet forest lands of 102,000 ha. In this section, the objective area for the plan is 86,000 ha of rainfed lands.

(b) Crop Selection and Cropping Pattern

The annual crops to be promoted with project condition are the same planted at present in rainfed lands of the Study area; Pigeon pea is the crop most widely planted in rainfed areas; the second most extensively planted crop is red bean; others are sweet potato, corn, banana, and plantain. The production of pigeon pea will be cultivated for 50% of the rainfed lands, mainly as a cash crop for marketing, while other crops such as red beans, corn, sweet potatoes, banana, plantain, etc. are grown for about 10% of the rainfed lands, mainly for farm household self-consumption. The remaining area will be grown by fruits such as mango, papaya, avogado and so on to stabilize farmer's income. Annual crops are planted entirely depending on the rainfall distribution pattern and planted at the beginning of August and September in San Juan province and at the beginning of September and October in Azua and Baoruco provinces.

(c) Proposed Farming Practices and Anticipated Yield of Crops

The proposed farming practices consist of (i) introduction of new varieties of pigeon

peas ('Indian' with 90 day-growing period) and red beans ('Checa'), (ii) crop rotation and use of inoculation of nitrogen-fixing bacteria to seeds of pigeon pea and red bean, (iii) application of organic compost and (iv) application contour farming.

The expected yield of crops under improved rainfed agricultural farming and production are summarized as follows:

Crop	Area (ha)	Unit yield (ton/ha)	Total production (ton)
Pigeon peas	43,000	1.3	55,900
Red beans	4,300	0.5	2,150
Corn	2,000	1.0	2,000
Sweet potato	2,150	8	17,000
Banana	1,100	16	17,600
Plantain	1,200	14	16,800
Orange	10,750	8.0	86,000
Mango	8,600	9.0	77,400
Papaya	4,300	20.0	86,000
Avocado	8,600	6	51,600

(d) Support Project Works

The agricultural supporting program consists of following four components:

(i) As mentioned in the previous section on the present conditions, since the rain-fed area is located in a remote area, it is difficult for the farmers to get sufficient agricultural extension services and information and their farming technique is low. This plan intends to conserve the soil conditions and to manage the low cost farming, which requires the new techniques for manuring, increasing nitrogen-fixing bacterium and conserving soil conditions and introduction of new crop varieties. For these new farming techniques, it is prerequisite to demonstrate and extend the new techniques to the farmers engaged in rain-fed cultivation. For the purposes of the demonstration and extension of new farming techniques, it is intended under this plan to establish eight demonstration farms; at Padre las Casas, Guayabal, Bohechio, Gajo de Monte and El Recodo in Azua province, Arroyo Canoa in San Juan province and Sabana Grande and Batista in Baoruco province. In each demonstration farm, a farm plot of 0.2 ha will be prepared and the demonstration and extension work will be made in this farm plot for 2 years for edible crops, and 5 years for fruit trees.

(ii) Twenty five nursery farms with a total area of 25 ha will be constructed to multiply the nurseries of fruit trees.

(iii) One year after commencement of the Project, the Project Office will provide the improved seeds of pigeon pea (645 tons) and red beans (366 tons) and nitrogen-fixing bacterium to the farmers.

(iv) As mentioned in Section 4.3.2, the capability of the extension workers will be enhanced through the training to them.

4.2.4 Coffee Production Improvement Project

(1) General

The main purposes of this development plan are to raise the earnings of 3,500 small

farmers, to improve farmers' living conditions and to conserve soil conditions in the mountainous area. In order to achieve these purposes, it is needed to rehabilitate the coffee plantation with a total area of 7,200 ha which are scattered in Azua and Baoruco provinces and covered with old coffee trees of which economic life has been expired, in order to increase the production, to improve the quality, to strengthen the marketability and to conserve the environmental conditions. Particularly for the increase of production, it is necessary to introduce an improved farming including the introduction of high-yielding varieties of trees. As for the improvement of the quality of products, it is needed to improve the processing method for harvested coffee beans. For strengthening marketing competitiveness of the products, it is intended to deal with the products not through the existing middlemen but through the well-organized agricultural cooperatives which are proposed to be established under the Project to collect the products , considering the that the coffee products have bargaining power in the market. As for the rural infrastructure, it is planned to improve the existing farm roads which have been heavily damaged, in order to facilitate the farmers' daily traffic and transportation of coffee products.

(2) Improvement Plan

The improvement plan to be introduced under the Project for coffee production is as mentioned below:

(a) Farming method to be introduced under the Project

The variety of coffee to be introduced to the project area will be Caturra which is of high productivity and easy for harvesting. The re-plantation will be done after 6 years. The planting density will be 1,600 trees/ha. Proper management for shade tree will be introduced through thinning and/or pruning practices. Pigeon pea will be used as inter-cropping crops during the first three years after replanting of coffee plantation. Fertilization is designed below:

Fertilizers	Planting year							
	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year
N(kg/ha)	45	50	50	80	100	150	175	195
P(kg/ha)	15	15	15	60	80	100	115	120
K(kg/ha)	15	15	15	20	30	40	45	60

(b) Production plan of nursery

Since the nursery of Caturra is in shortage in the project area, it is planned to multiply the nursery in the nursery beds to be constructed in the project area. The multiplication of the nursery will be made using the registered seed nursery to be provided by the Ministry of Agriculture. The seed nurseries will be soaked for 24 hours and then planted being packed in polyethylene bags.

(c) Construction of processing facilities and establishment of cooperatives

In this plan, the coffee beans will be processed by employing the wet fermentation method. In order to produce a high quality of coffee, the present old processing facilities will be replaced by new ones with a larger capacity. For this replacement, threshers, pulping facilities, selecting/grading facilities and weighing facilities will be procured and the

drying yards will be improved under the project. Each processing facility will jointly be operated and maintained by 20 coffee cultivating farmers with a total cultivation area of 40 ha, being organized in a group.

(d) Pilot farm plan

A pilot farm is planned to be constructed in each province of Azua and Baoruco. The farm area will be 40 ha for each. The purposes of the farm are: (i) to confirm the technical and economical justification for planned farming method; (ii) to enhance the ability of extension workers; and (iii) to transfer the proper farming techniques to the coffee cultivating farmers.

(e) Improvement of farm roads

The following existing farm roads will be paved with gravel to facilitate the dwellers' daily traffic and transportation of coffee:

District or Section	Route of road	Length(km)
Azua Province		
Guayabal M.District	Padre las Casas to Monte Bonito	14
Monte Bonito	Padre las Casas to Monte Bonito	7
Los Frios	Padre las Casas to el Desecho	
	El Desecho to El Limon	7
	El Limon to Los Frios	9
Bahoruco Province		
Guayabal, Galvan	Galvan to Las Tejas	3
	Las Tejas to Guayabla	14
Apolinar Perdomo	Neyba to Sesaindo Paso	4
	Sesaindo Paso to Apolinar Perdomo	8

(f) Establishment of management organization and agricultural cooperatives

The Ministry of Agriculture will be the executing agency of the Project, and an office for improving the coffee farming techniques will be established for the implementation of the Project. The project implementation period will be 11 years. In order to avoid unreasonable profit of the middlemen through trading the coffee beans, it is intended to establish agricultural cooperatives which will function for collecting and distributing coffee beans. As mentioned above, about 180 cooperatives will be established in the Project area. Each cooperative will consist of 20 coffee cultivating farmers. Immediately after establishment of the cooperatives, the leaders of cooperatives will be trained for the subjects of rules and regulations of the cooperatives, management of the cooperatives, marketing, financial management, farming techniques for coffee cultivation, operation, maintenance and management of coffee processing facilities, and transaction of loan. The training will be conducted to develop the agricultural techniques to 15 extension workers who are in charge of the project area.

(3) Project Works

The project consists of (i) setting up organization and/or strengthening of 180 small coffee farmers agricultural cooperative, (ii) development of two Pilot areas of about 40 ha each, (iii) training of 5 coffee specialists, 15 extension workers and 180 farmer's leaders, (iv) development and planting of coffee nurseries with an area of 23.4 ha, (v) replanting of 7,120 ha of old coffee plantations (1.2 million of seedlings), (vi) construction of drying floors(23.3 ha) and one small storage with a capacity of 2.3 ha, (vii) procurement

of equipment for 180 set each for threshing and pulping cherry coffee, 180 set cleaning and weighing the dry coffee beans, (viii) improvement of 66 km existing rural roads, (ix) introduction of improved farming practices, (x) procurement of 15 motorcycles and (xi) procurement of education and training materials and equipment.

(4) Cost

The total estimated costs for the Coffee Production Improvement Project are estimated at 249.8 million DR$.

4.3 Plan for Strengthening Agricultural Support System

4.3.1 Plan for Credit Services

One of the main constraints found in the Study area is the inability to access formal credit. This in turn prevents farmers from introducing modern techniques and increase production and income.

A pilot project composed of two lines of credit to increase agricultural production and reduce poverty through expanding horizontal and vertical outreach of loans to small and medium farmers and poor residents is proposed. The basic concept of credit plan is to apply group loan and reduce the handling charges.

(1) Rural Development Fund

This credit line from the pilot project will be used to overcome imperfections in the rural credit market by opening market access to groups previously excluded due to remote location, inadequate collateral and limited resources of formal financial institution. This general line of credit will be used to make short, medium and long term credit for agricultural and other viable rural operations. Those intermediaries will be the water user associations, farmers' associations and Non Government Organization working in the Study area.

This pilot project will provide start-up funds for 5 years. This line of credit will be channeled and managed by the Agricultural Bank. The interest rate is 12-14%.

Staff required for operation consists of 1 manager, 1 secretary, 6 credit/accounting staff, 3 credit officers, 1 lawyer and 1 accountant. Office equipment such as computers, fax, printer, etc. will be required. Also vehicles are needed. Details are shown in Table 4.3.1 in Annex-1.

The total project costs are estimated at 116.5 million US$, consisting of 100.8 million US$ for credit capital, 330,000 US$ for procurement of office equipment, 635,500 US$ for procurement of vehicle and 14.7 million US$ for staff salary. O&M cost for 5 years are 2.82 million DR$.

(2) Fund for Rural Poor

The project will provide loans to poor farmers, small merchants, women, etc. who have difficulty in accessing normal credits. It is suggested that a Trust Fund to assure

sustainability in the supply of funding for this credit line should be created. It is proposed that the Special Fund for Agricultural Development (FEDA) is responsible for this fund. A special unit at FEDA should be instituted to supervise and manage this line of credit and coordinate with local intermediaries in the Study area. This pilot project will provide start-up funds for 5 years. The interest rate is 12-14%.

Staff required for operation consists of 1 manager, 1 secretary, and 3 credit officers. Office equipment such as computers, fax, printer, etc. will be required. Also vehicles are needed. Details are shown in Table 4.3.2 in Annex-1.

The total project costs are estimated at 70.9 million US$, consisting of 62 million US$ for credit capital, 150,000 DR$ for procurement of office equipment, 635,500 US$ for procurement of vehicle and 8.1 million US$ for staff salary. Estimated O&M cost amounts to 2.45 million US$ for 5 years.

4.3.2 Plan for Extension and Research Services

(1) Strengthening of CIAZA Station

The basic concept of research of the plan is to strengthen the research function of CIAZA which will provides basic technology necessary for the successful implementation of the proposed agriculture, and irrigation and drainage projects. For this purpose, CIAZA integrates all stockholders in the generation and deliver of technology. Also reinforcement of institutional capacity as well as equipment/facilities will be undertaken.

This project includes the following three components: i) improvement of CIAZA institutional capacity and development of a sustainable source of funding for research activities at CIAZA, ii) a training program for CIAZA researchers; iii) strengthening of CIAZA facilities to undertake research.

It is proposed that the 'Research Trust Fund' as shown in Figure 14 should be established as to obtain research funds and efficient development of applied technology. The member of the Fund is composed of governmental agencies, private sector, academic research sector, water user's organization etc. It is suggested that qualified researchers should be included. The project also contemplates to strengthen CIAZA research capacity by providing training to the current 6 research staff through training of 'Master Degree Program that is now performed by the Government, ISA, and FDA and various training /seminar programs. In order to strengthen research capacity at CIAZA it is proposed to acquire lab equipment, office equipment and facilities and farm machinery to carry out adaptive and basic research as shown in Table 4.3.3 and 4.3.4 in Annex-I.

(2) Training Programs for Extension Workers

There are 178 extension workers in the Study area. The activities of extension work are limited due to a) insufficient number of trained extension workers, b) lack of transport facilities and c) lack of modern extension aids for technical transfer. The basic concept of the plan for strengthening extension services is given the highest priority to improve the capability of the extension workers. For this, training for the extension workers will be performed in the existing training centers at San Juan and Barahona and

reinforcement of training equipment and materials.

It is planned that all extension workers should be trained on four aspects: a) technical issues, b) methodological aspects, c) managerial aspects and, d) organizational aspects. This training will be carried out at the existing training centers at Barahona and San Juan during the five years through short courses, workshops, seminar conference and field trips. Training will be provided by specialists of SEA and staff of universities. Demonstration farms will be set up at the two training centers on the training of extension workers. The project will furnish office facilities, training materials, rehabilitation of buildings and vehicles of which details are shown in Tables 4.3.6 and 4.3.7 in Annex-I.

(3) Costs

The total costs for strengthening of CIAZA plan consist of equipment, training, vehicles, salaries of staffs and recurrent costs and are estimated at 24.8 million US$ as shown in Table 4.3.4 in Annex-I. In addition to this cost, 77.5 million will be necessary for trust fund. The total cost for the training program for extension workers consists of equipment, training, transportation means, salaries of staffs and recurrent costs and is estimated at 23.3 million US$ as shown in Table 4.3.7 in Annex-I.

4.3.3 Plan for Seeds Multiplication

(1) Target Production

The extensive use of poor quality seeds and seedlings is one of the main causes of low yield and production of main crops obtained by farmers in the Study area. It is necessary to ensure availability and extensive use of good quality seeds by farmers in the Project areas, in order to increase yield of crops. A plan for multiplication of seeds and seedlings of main crops in the Study area is proposed to produce the quantity of seeds and seedlings necessary to ensure planting the different proposed Project areas. The target quantity of seeds and seedlings to be produced annually in each irrigation zone of Azua, San Juan, Yaque del Sur, and Lago Enriquillo are summarized below.

	Rice (ton)	Bean (ton)	Pigeon pea (ton)	Corn (ton)	Sorghum (ton)	Number of Seedlings/year	
						Plantain	Banana
Azua		86	12	20	8	0.9 million	0.37 million
San Juan	957	907		50	15		
Yaque Sur and Lago Enriquillo				35	17	1.82 million	0.263 million

Note: All seedlings of Plantain and Banana will be produced by CIAZA by tissue culture method.

(2) Seeds and Seedlings Multiplication in CIAZA

It is proposed to enlarge and strengthen the capacity of CIAZA for seeds and seedling multiplication. CIAZA will be responsible for performing multiplication of seeds of bean, pigeon pea, corn, and sorghum, and seedlings of plantain and banana required for the Project areas in Azua, Yaque del Sur, and Lago Enriquillo irrigation districts.

(3) Selection of Farmers for Seeds Multiplication

The association of Farmers of San Juan de la Maguana (APASJM) has been multiplying seeds of bean and rice under contract agreement with the Ministry of

Agriculture. It is planned to expand and strengthen the capacity of APASJM for them to dedicate the necessary area for multiplication of certified seeds of bean, rice and sorghum in the area of San Juan irrigation district.

(4) Necessary Equipment and Facilities

The equipment necessary for implementation of seed multiplication plan are: 5-tractors, 5-plowing attachment, 5-seed planter attachment, 5-harvester, 2-corn sheller, 12-sprayer, 5-seed classifier, 5-seed packaging, 5-weight scale, 1 unit for tissue culture, 5-truck, 6-power generator, 5-temperature/air humidity control equipment, dry floor with 5,500 m^2 and storage facilities with 3,260 m^2. Details are shown in Table 4.3.9 in Annex-I.

(5) Costs

The total costs for seeds and seedling production plan in CIAZA and APASJM are estimated at DR$27.354 million, consisting of DR$5.414 million for CIAZA and DR$21.94 million for APASJM.

4.3.4 Plan for Agricultural Cooperatives

(1) General

There exist about 200 village level agricultural cooperatives and San Juan and Azua Cooperative Federations in the Survey Area. As explained in Section 3.7.4, both of Azua Cooperative Federation organized mainly by tomato and banana cultivation farmers and San Juan agricultural cooperative comprising of rice and red beans cultivation farmers are providing the small scale credit services as well as cooperative collection and delivery of farm produce, then the operation is generally well managed. Whereas, cooperatives in the other province are organizationally weak, and insufficient in capacity of providing the services to members for the market information. The Project aims to orderly strengthen the agricultural cooperatives at the village level in Barahona and Baoruco province as well as to encourage the activities of agricultural cooperatives, consisting mainly of collective collection and delivery of agricultural produce, manufacturing/marketing by means of setting up of cooperative federations in Barahona and Baoruco provinces and a superordinate organization (Yaquedelsur Farmers Marketing Federation) above 4 provincial federations.

(2) Strengthening Plan of Agricultural Cooperatives

Main crops produced in Barahona and Baoruco provinces are plantain and banana, about 90% of which are marketed mostly in Santo Domingo city by middlemen. With the project implementation, the existing agricultural cooperatives will be strengthened in order to bring up the agricultural cooperatives capable of carrying out cooperative collection and delivery of plantain and banana besides small scale credit service under the guidance of IDECOOP, which includes the service for increase of participating members, revision of the present bylaws of the cooperatives, capacity building of cooperative leaders in managerial and financial aspects. Also new agricultural cooperatives will be set up. Since the cooperatives are as small in member as less than 20 and have no super-ordinate organization, they have no bargain power towards marketing of plantain. To cope with this inferior condition, it is required that provincial-level federations at Tamajo city in

Baoruco province and Barahona city in Barahona province be established, and the cooperative collection and delivery be carried out through the federation. As illustrated in Fig.15, three-tier system are proposed, i.e., at village level, at provincial level and at Yaquedersur river basin level. Finally Yaque del sur Farmers Marketing Federation will be organized at the basin level.

For setting up these organizations and operation, and agricultural cooperatives, technical guidance and training for the members of the Market Board and provincial federations will be performed by consultants for 4 years.

Staff required for operation consists of 1-manager, 1-secretary and 4-market technician. Office equipment such as computers, fax, printer, etc will be required. Also vehicles are needed. Details are shown in Table 4.3.10 in Annex-1.

(3) Costs

The total project costs are estimated at 20.8 million US$, consisting of 5.86 million US$ for procurement of office equipment, 1.28 million US$ for procurement of vehicle, 4.68 million US$ for technical guidance service, 302,300 US$ for training program and 8.68 million US$ for staff salary. Estimated O&M cost amounts to 1.05 million US$ for 5 years. Details are shown in Table 4.3.10 in Annex-I.

4.3.5 Market Information Systems

(1) General

There are no organizations that systematically provide data and information about prices of farm input and outputs, location of sale and market, market requirement classified by grade, list and activities of dealers on agro-processing and machinery. SEA provides irregular services of market information with farmers. Also Agricultural Business Council (JAD) is undertaking the market information system in cooperation with SEA, custom office, Export Promotion Center, suppliers of farm inputs, associations of farmers' cooperatives, and others. Under JAD in Santo Domingo there are several branches in which provincial agricultural cooperatives take part. Market information is exchanged between JID headquarters and the branches. It is necessary to strengthen these market information systems through reinforcement of communication equipment and staffing.

(2) Proposed Plan

The project will set a market information system that will cover the four provinces of the Study area with headquarters located in Santo Domingo. The Dominican Agribusiness Council (JAD) could handle the headquarters of the Market Information System. Under JAD, information centers in the Study area will be established at farmers' associations in San Juan, Azua,Barahona and Baoruco province. The market information centers will be set at the COOFEPRO in Azua, San Juan Agricultural Cooperative in San Juan and proposed Federations of agricultural cooperatives at Tamayo city in Baoruco province and Barahona city in Barahona provice. Market information is exchanged between JID headquarters and the branches and will be distributed to the farmers in the Study area.

Staff required for operation consist of 1-manager, 1-secretary and 3-system operator. Office equipment and transport means is planned. Furthermore, education and training programs for system operators will be carried out. Details are shown in Table 4.3.11 in Annex 1.

(3) Costs

The costs for market information system project contain procurement of equipment and transportation means, personnel costs and O&M costs and are estimated at 8.54 million DR$ of which details are shown in Table 4.3.11 in Annex 1.

4.4 Overall Water Management Plan in the Yaque del Sur Basin

4.4.1 Principle

(1) Basic rule of water allocation

Water resources in the San Juan River and Sabaneta Dam should be primarily allocated to the area in the San Juan irrigation zone. Water in the Yaque del Sur River, as a fundamental rule should be primarily utilized in the Yaque del Sur River Basin and water created by Sabana Yegua Dam should be fairly diverted between Barahona-Neiba area and Azua area in proportion to the registered irrigation area. If the allocation is based on this consideration, about 70 percent of the Yaque del Sur River flow should be allocated to the Barahona-Neiba area and remaining should be diverted to the Azua area.

(2) Early implementation of improvement works of Villarpando headworks

Among the headworks, the Villarpando headworks is the most important headworks, which commands the large irrigation area in the Azua and the Barahona-Neiba areas. The discharge records at the Villarpando during the dry season indicate that about two-third of total flow was diverted to the YSURA canal and the remaining one-third was flowing down to the Barahona-Neiba area, despite the fact that the Barahona-Neiba area is two times larger than the Azua. Such imbalance in the water distribution at the Villarpando is mainly caused by the defects in the Villarpando diversion works. They should be primarily improved so as to enable even distribution of the limited river waters.

(3) Establishment of Water Management Center at Villarpando

Azua Irrigation District currently operates Villarpando headworks, which may be one of the causes of uneven distribution. It is considered necessary to establish an independent water management function to manage the river water distribution to both Azua and Barahona-Neiba areas.

4.4.2 Organization

(1) Overall Organization

Water management will be conducted and supervised conforming to a water management institution which consists of three management levels: i) inter-basin water management (LEVEL-1), ii) basin water management (LEVEL-2), and iii) irrigation-

system-wise water management (LEVEL 3).

The irrigation-system-wise water management is a basic unit of the water management, which covers an irrigation system with one intake and its command area. The management itself will be entrusted to Water Users' Associations (WUA), including maintenance of all the irrigation facilities, collection of water charges, and so on. Each Irrigation District will support the WUAs on maintenance of irrigation facilities, water management techniques, and coordination between government organizations and WUAs.

Location of the offices and related irrigation systems are illustrated in Figure 16, and an overall administrative chart is given in Figure 17.

(2) Yaque del Sur Water Management Center (Level 1)

Functions of the Yaque del Sur Water Management Center (hereinafter referred to as "WM Center") are: i) to monitor and evaluate water budget at relevant control points, ii) to operate and maintain facilities directly and indirectly according to the results of evaluation, iii) to coordinate water distribution through a year, and iv) training of staffs and WUAs,

It is also recommended to invite experienced consultants or foreign experts on a project basis, particularly for the initial stage.

(3) Irrigation District Office (Level-2)

Field offices will be established at three locations in San Juan, Azua and Barahona/Neiba block. San Juan Field Office will be established near the Sabaneta Dam as a branch of San Juan Irrigation District. The office will manage the water distribution within the San Juan block in order to realize efficient use of the available water in the block, support the existing WUAs and to operate and maintain the telemetering system.

Azua Irrigation District will play roles in: i) operation of the telemetering system, ii) water management for the Ysura conveyance canal and its irrigation system, iii) monitoring of existing tubewells (number, location, groundwater table, discharge, water quality particularly on salinity, and iv) supporting services for WUAs.

Santana Field Office will be established at Santana headworks under administration of Irrigation Districts of Yaque del Sur and Lago Enriquillo. Each Irrigation District Office will perform supporting services for WUAs. Lago Enriquillo Irrigation District Office will do monitoring of existing tubewells (number, location, groundwater table, discharge, and water quality) in Neiba-Galvan area.

4.4.3 Operation Rule of Sabaneta and Sabana Yegua Dams

(1) Organization for Operation of Dams

Considering smooth implementation and management of the proposed water distribution in the Project area, it is recommended to utilize the present organizations and systems of the dam operations such as the Council on the Control of Dam Basins and the Committee for the Operation of Dam Basins. As for the operation of Sabana Yegua and

Sabaneta Dams, the chief of the Yaque del Sur Water Management Center will be a member of the Committee for the Dam Control of Basins. Operations of the irrigation and water distribution facilities in the Yaque del Sur River Basin will be determined by the Center as well as the dams.

(2) Ordinary Operation

So far no standard storage curve has been established in the Dominican Republic. It is recommended to generate a **standard drought storage curve**, which is to be used for maintaining a certain volume of storage and securing stable water supply during drought periods. The standard drought storage curves of Sabaneta Dam and Sabana Yegua Dam were generated on the basis of the simulation results of the dam operation as given in Figure 4.4.4 and Figure 4.4.5 in Annex 1.

The Dam operation during the ordinary period will be conducted so that the water levels of the reservoirs are maintained above the standard levels.

(3) Emergency Operation

The emergency Dam Operation Committee (COEE) issued an instructive manual on operation of Sabaneta Dam in August 1998[4] and Sabana Yegua Dam in July 1998[5]. The emergency spillway of Sabaneta Dam was improved by PRODAS in 1997/98 and the maximum operation level was set at 643-m amsl. The manual for the Sabaneta Dam, which is mentioned in detail in the Annex-2, is considered quite reasonable. However, taking into account the disaster caused by Hurricane George in 1998, it is recommended to notify the actual operation and expected discharges through the spillways to the downstream by a discharge warning system as mentioned in Sub-section 7.7.3.

The maximum operation level of Sabana Yegua Dam is set at 386 m amsl, 10 m lower during the hurricane season because of a revised design flood after Hurricane David (1979) and some structural problems on the emergency spillways. The present operation rule during the emergency period should be maintained and re-evaluated in relation with the proposed improvement works of the spillways. It should be noted that the revised design flood inflow cannot be discharged through the existing spillways even with any lower maximum operation levels. The physical improvement works should be the primary consideration on the Sabana Yegua Dam.

4.4.4 Operation Rule of Villarpando Headworks

(1) Basic Concept

The basic concept of the operation of the headworks is **"even distribution of available water"** through out the year, even while the total volume of available water is less than that of demands.

Being located at the downmost control point to both Barahona and Azua blocks, Villarpando headworks has a decisive function in the water distribution. Even if the

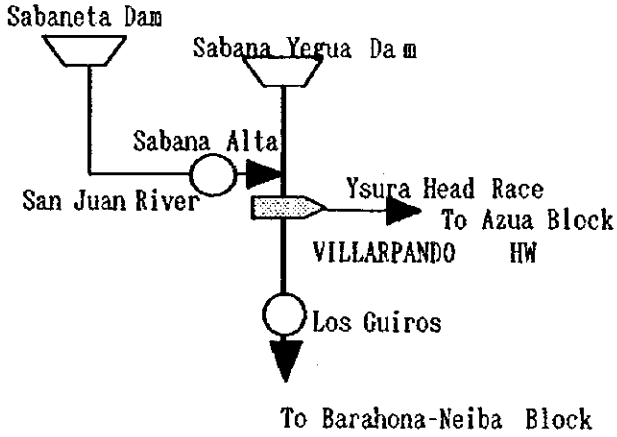
[4] Instructivo de Operación de Emergencias ~ Presa de Sabaneta
[5] Instructivo de Operación de Emergencias ~ Presa de Sabana Yegua

operation of Sabana Yegua Dam is well managed, the waters can not be distributed properly without good operations of the headworks. In this sense, the operation of Sabana Yegua Dam during dry periods might be considered as a part of operations of Villarpando headworks.

(2) Distribution of Available Water at Villarpando

(a) The operation of the headworks is conducted by the Yaque del Sur Water Management Center established at the Villarpando headworks.

(b) Hydrological check points of which discharge data are used for determining of the operation are; (i) Sabana Alta on the San Juan River, and (ii) Los Guiros on the Yaque del Sur River. A conceptual diagram is given below:



(c) The Water Management Center collects and compiles the discharge records from Sabana Alta using the telemeter system, then determines or adjusts the discharge from the Sabana Yegua Dam.

(d) The waters at the headworks are diverted to the Ysura Head Race Canal according to the water demands of Azua and Neiba-Barahona block. The river discharge at Los Guiros will be monitored simultaneously.

(e) If the discharge at Los Guiros is smaller than the proposed discharge for the period and the water level at Sabana Yegua Dam is above that of the standard storage curve, the discharge from the dam will be increased.

(f) If the river discharge at Villarpando does not meet the demands due to insufficient storage of Sabana Yegua Dam, the available water at the headworks will be distributed in reduced volume.

4.4.5 Improvement Project of Villarpando Headworks

(1) Basic Plan of Facilities

The existing Villarpando headworks consist of i) intake structure, ii) sand flushing sluice, iii) concrete fixed weir of spillway and iv) earth dike.

At present, in addition to the malfunction of the gates, there are the structural defects on the headworks as mentioned in section 3.5.3. In this context, discharging sluice facilities should be provided on the existing weir for the purpose of releasing water to the downstream reaches steadily. In this structure, the sill of the gates should be set at the same elevation of those of the intakes in order to put both structures under similar hydraulic conditions. Furthermore, in terms of operation and maintenance, dimension of the intake gate will be applied to the gate in the discharging sluice. On the other hand, all the existing gates in the intake and the sand flushing sluice should be replaced with new ones including motor-driven lifting devices.

Stone masonry work should be provided as protection works at the portion where erosion and scouring will occur (especially adjacent parts to the sand flushing sluice and discharging sluice).

(2) Project Works

- Replacement of gates and lifting devices at intake / sand flushing sluice structure;
  i) 3 nos. of slide gates with motor-driven lifting device;1.9m (B) x 2.5m (H)
  ii) 1 radial gate with motor-driven lifting device: 4m (B) x 7.2m(R)
- Rehabilitation of protection works at up/downstream portion of sand flushing sluice, discharging sluice and concrete fixed weir
- Provision of discharging sluice with 3 nos. of steel roller gates [1.9m (B) x 2.5m (H) x 3 nos.]

General features of the improvement project of Villarpando headworks are shown in Figure 4.4.6 in Annex 1.

4.4.6 Hydrological Network and Telemetering System

(1) Flood Warning System

A flood warning system aims at giving a cautionary notice of the likelihood of flood levels or flows exceeding specified limits, given from upstream station to points downstream, to enable timely protective measures to be taken to minimize damage to life and property.

The proposed warning system consists of the following facilities:

- Electric (motor) siren with remote control system
- Loudspeaker with remote control system
- Patrol car with a loudspeaker system
- Sign plates, etc

(2) Telemeter Stations for Water Management

The telemeter system for the irrigation water distribution will be operated by the Yaque del Sur Water Management Center. The primary telemeter system covers data control and operations of Sabaneta Dam, Sabana Yegua Dam, Villarpando headworks, Sabana Alta on the San Juan River, and Los Guiros on the Yaque del Sur River.

(3) Component of the Telemeter System

The data control system is composed of the transmission system, monitoring and operation system, data processing system, and power supply system.

(4) Basic Plan of Facilities

The telemetering system is proposed for Level-1 and Level-2 water management. The Level-1 system consists of The Yaque del Sur Water Management Center as the central station, Villarpando headworks station which is located near the Center, Sabana Yegua and Sabaneta Dam stations (including San Juan Branch Office), Sabaneta headworks station, Sabana Alta and Los Guiros hydrological stations, and repeater stations. The Level-2 system consists of the telemetering stations of Santana headworks, Azua Branch Office, Santana Branch Office and Rincon Lagoon station.

The basic plan of telemetering system is given in Figure16.

4.4.7 Training Program

(1) Program

Training on the water management is proposed for each management level, i.e. i) water users' associations (WUA), ii) staff of the water management offices, and iii) staff of the water management center. An intensive training course will be prepared and practiced at the initial stage of the Project for the staff of the water management center, and trainers for WUAs. Then the trained staffs of the Center will succeed the training and instruction activities for lower-level staffs and/or WUAs.

(2) Equipment

The following equipment will be facilitated for the training:

(i) personal computer
(ii) television and video
(iii) video camera
(iv) camera
(v) micro bus
(vi) pick-up truck
(vii) motorcycle
(viii) handy radio transceiver
(ix) copy machine
(x) overhead projector
(xi) office furniture and utilities

4.4.8 Costs

The total project costs for the overall water management project is summarized as follows:

Costs for Water Management Project

Items	Cost (x 1000 DR$)
1) Improvement of Villarpando headworks	35,239
2) Yaque del Sur Water Management Center / Villarpando headworks Operation Unit	21,980
3) Sabaneta Dam Remote Station	6,888
4) Sabana Yegua Dam Remote Station	6,018
5) Sabana Alta Hydrological Remote Station	1,932
6) Los Guiros Hydrological Station	1,932
7) Tabara Remote Station	5,516
8) Santana Remote Station	5,516
9) Training Program A (for Level-2 staff. 20 courses, 25 participants each)	392
10) Training Program B (for Level-1 staff. 10 courses, 20 participants each)	798
Total	86,239

4.5 Irrigation and Drainage Development Plan

4.5.1 Development Concept

According to the hearing to water user's organizations and farmers, water shortage is a main problem. It is indicated in the water balance study as well. The most important subject is, therefore, how to effectively utilize limited water resources in the Yaque del Sur River through improving irrigation efficiency. In this context, there is still much room for improvement in the existing irrigation facilities and water management systems and thus the irrigation development should place the highest priority on the improvement of the water management system and existing irrigation.

In order to use water efficiently, the following matters should be proceeded together with the establishment of the water management center proposed for the basin water management in Section 4.4.2.

(1) Diversion structures and free intakes should be improved or replaced with new ones to exactly divert water to meet the scheduled amount,

(2) WUO enabling farmers to be more involved in the O&M of irrigation and drainage systems should be founded in each, or a group of, irrigation systems and reinforced in order to manage systems by themselves, and

(3) Existing irrigation and drainage systems should be rehabilitated and improved so that WUO receive the systems in good operation condition.

4.5.2 Irrigation Water Requirements

The irrigable area was estimated by a water balance study between water supply and demands, which is presented in Section 4.7. For this water balance study, future irrigation water requirements were estimated on the assumption that the irrigation efficiency would be improved by proper water management performed by INDRHI and WUOs under the improved irrigation facilities and systems. In addition to the existing irrigation areas, on-going irrigation projects are taken into account in the estimate of the irrigation water requirements. Cropping patterns are based on the present patterns, with slight modifications in the crop growing period and sugarcane cropping area.

The irrigation efficiency with project condition is assumed as follows:

Irrigation systems other than J.J. Puello and YSURA areas
0.47 for upland crops
0.58 for paddy
J.J. Puello and YSURA areas
0.44 for upland crops
0.54 for paddy

Irrigation water requirements are shown in the following table.

Summary of Irrigation Water Requirements in the Area served by the Yaque del Sur River balancing with the available river water resources with Project Condition

(Drought in 80% dependability)

Irrigation Zone & System	Nov.	Dec.	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
San Juan Irrigation Zone													
J.J.Puello	4.4	11.9	19.0	10.2	2.8	2.4	7.1	13.8	11.7	10.2	6.2	4.1	103.7
San Juan	3.0	10.7	18.6	10.5	3.1	1.5	6.8	13.8	13.5	11.3	7.8	4.6	105.4
Hato de Padre	0.6	2.4	4.4	2.5	0.9	0.6	2.3	4.2	3.9	3.5	2.6	1.5	29.4
Guanito S. Juan	0.4	1.8	3.2	1.6	0.2	2.0	3.1	4.7	3.9	2.7	1.3	0.5	25.4
Other systems	0.7	2.8	5.2	2.9	0.9	0.6	2.7	5.2	4.9	4.4	3.1	1.8	35.3
Mijo	2.7	3.5	5.2	3.1	1.3	1.1	3.2	5.8	7.2	5.6	4.2	3.1	45.9
Vallejuelo	0.9	1.0	0.4	0.1	0.2	0.3	0.2	0.5	0.5	0.3	0.1	0.1	4.5
Total	11.8	33.0	55.5	30.8	9.3	8.3	25.1	47.6	45.2	37.7	25.1	15.5	345.0
Azua Irrigation District Zone													
YSURA H.R	1.5	2.2	2.7	2.2	1.8	1.6	1.3	1.8	2.6	1.9	1.3	0.9	21.9
A&B	2.8	3.4	3.6	3.8	4.3	3.9	3.0	3.8	5.1	3.7	2.5	1.6	41.5
YSURA area	13.0	19.4	20.4	19.3	17.3	17.8	14.5	17.7	19.3	13.5	8.8	5.6	186.7
Total	17.3	25.0	26.7	25.4	23.4	23.4	18.9	23.4	26.9	19.2	12.6	8.1	250.1
Yaque del Sur - Lago Enriquillo Zone													
Area A1 (Azua)	4.1	5.9	7.3	7.3	6.7	4.8	3.8	5.2	7.7	5.9	3.9	2.5	65.0
Area B1	5.6	6.2	7.0	7.0	8.5	7.9	6.6	7.1	9.7	7.8	6.3	5.3	85.0
Aguacatico	1.5	1.6	1.9	1.8	2.2	2.1	1.8	1.9	2.5	2.0	1.7	1.4	22.5
Area B2	23.1	26.7	28.6	22.3	20.8	20.1	20.7	25.5	35.9	31.5	29.7	22.0	306.9
Area B3	5.8	6.4	7.2	7.2	8.6	8.1	6.7	7.2	9.9	7.9	6.5	5.4	86.9
Area B4	0.7	0.8	0.9	0.9	1.1	1.0	0.9	0.9	1.3	1.0	0.8	0.7	11.3
Area B5	3.3	3.7	4.1	4.1	4.8	4.5	3.7	4.0	5.5	4.5	3.7	3.2	48.9
Area B6	5.8	6.3	7.0	6.8	8.2	7.6	6.2	6.8	9.4	7.7	6.5	5.6	83.7
Total	50.0	57.6	64.0	57.5	60.9	56.0	50.2	58.7	81.8	68.3	59.1	46.0	710.1
Grand Total	79.1	115.6	146.2	113.7	93.6	87.7	94.2	129.6	153.9	125.2	96.9	69.6	1305.2

YSURA H.R : a group of small areas directly derived water from YSURA Head Race by private pipes.
A&B : Amiama Gomez & Biafara area, newly completed project
YSURA area : including the extension area about 1,140 ha
Area A1 : irrigation area in the reaches from Villarpando to Los Guiros up (Azua Irrigation Zone)
Area B1 : irrigation area in the reaches from Los Guiros to Santana upstream
Area B2 : Santana irrigation area
Area B3 : Irrigation area in the reaches from Santana downstream to Tomate-Mena upstream
Area B4 : Irrigation area in the Tomate-Mena system
Area B5 : Irrigation area in the reaches from Tomate-Mena downstream to Palo Alto upstream
Area B6 : irrigation area in the reaches from Palo Alto to the sea.

4.5.3 Irrigation and Drainage Development Plan in San Juan Irrigation Area

(1) Night Storage Pond Projects

Existing irrigation areas such as J.J.Puello irrigation area (10,986 ha), Hato del Padre irrigation (2,059 ha), San Juan irrigation area (5,526 ha), which are served by the San Juan River and Mijo irrigation area (2,390 ha) served by the Mijo river are being improved in the irrigation canal systems under PRODAS or PROMASIR with the provision of concrete lining and elevated flumes. In order to further enhance the irrigation efficiency, it is proposed to provide night storage ponds in their irrigation systems so that the irrigation water is stored in the ponds during the night time and released during the daytime from early morning to evening when farmers are working in the fields. The ponds should be

located near the benefited fields so that the water users easily control the water distribution from such ponds. Capacity of a night storage pond is estimated at 5,000 m^3 per 100 ha of the irrigation area on the assumption that the peak irrigation requirement is 1.1 lit./sec./ ha and water releasing time is 12 hours a day.

Night Storage Ponds

System	Area	Total capacity of ponds ($x10^3m^3$)	Nos. of ponds	Volume of earthwork($x10^3m^3$)
J.J. Puello	10,986 ha	523	15	560
Hato de Padre	2,559 ha	98	3	120
San Juan	5,526 ha	263	8	300
Mijo	2,390 ha	114	5	170

(2) Guanito San Juan System Improvement Project

Guanito San Juan area is located at the southern part of the San Juan. The irrigation area is 1,000 ha in total. The major project works are estimated as follows:

- Construction of night storage ponds, the total storage: 48,000m^3
- Concrete lining in the last reaches of 8 km of the main canal.

4.5.4 Irrigation and Drainage Development Plan in Azua Irrigation Area

(1) YSURA Area Improvement Project

The improvement of drainage conditions in the southern part of the Azua area where the condition of salinity is revealed due to the poor drainage condition will be implemented under PROMATRES. In addition, the YSURA irrigation system is proposed to be rehabilitated in the damaged portions especially in the steel gates of turnouts and checks and improved with provision of night storage ponds.

Night Storage Ponds

Lateral	Area (ha)	Total capacity of ponds ($x10^3$ m^3)	Nos. of ponds	Volume of earthwork ($x10^3$ m^3)
1	2,237	107	5	149
2	1,116	54	2	66
3	184	-	-	-
4	1,104	53	2	66
5	1,408	67	2	75
6	1,683	80	3	101
Total	7,732	361	14	457

Note: Total capacity is estimated on the assumption of the peak irrigation requirement of 1.1 l/s/ha and 12 hours operation for water releasing from the pond.

(2) YSURA Extension Area Development Project

The Project area is 2,275 ha in total, located at the downstream reaches of YSURA irrigation area between the Jura River and the Via River, and served by an old and quite poor irrigation system. Both surface water and groundwater resources can be utilized for the improvement of the irrigation system in this area.

The major project works are estimated as follows:

- Improvement of YSURA Main Canal with concrete lining in the downstream extension reaches about 8 km,
- Rehabilitation and improvement of existing canal system with concrete lining

(lateral canal; 10 km),
- Provision of 2 nos. of night storage ponds (Capacity = 55,000m^3),
- Reinforcement of water users organization, which will be incorporated into the YSURA Canal Irrigation Committee.
- Provision of approximately 60 numbers of deep tubewells.

(3) YSURA Headrace Small Irrigation System Improvement Project

The project aims to improve the disorder by water diversion from the YSURA headrace by privately installed pipes by setting up and reinforcing WUO and installing permanent intake structures.

- Replacement of existing private pipes with new intakes along YSURA Headrace canal; 75 nos.
- Improvement of conveyance system for the total area of 1,100 ha.
- Set up and reinforcement of WUO.

4.5.5 Irrigation and Drainage Development Plan in Lago Enriquillo and Yaque del Sur Irrigation Area and Small Gravity Irrigation System Improvement Project

(1) Yaque del Sur Lower Reaches Irrigation and Drainage Improvement Project

Yaque del Sur Lower Reaches Irrigation and Drainage Improvement Project will cover the existing irrigation area (19,458 ha) served by the Yaque del Sur River in the downstream of Santana headworks.

The Santana irrigation system, which was built in 1916 should be completely improved in the whole area with the provision of concrete lining and night storage ponds, among other items. Many small irrigation systems, most of which are served by pumps located along the lower reaches of the Yaque del Sur River, can be unified into two long main canal systems every left and right side area of the Yaque del Sur River. The right side area will be served by the existing Santana canal system to be completely improved. A new canal will serve the left side area. Some small pump irrigation systems excluded reluctantly from the above gravity systems due to geographical difficulty will be improved with the provision of regulation ponds for use during the interruption of electric supply. The major project works are as follows:

- Setting up and reinforcement of WUO,
- Replacement of Santana headworks in the intake and sand flushing structure,
- Rehabilitation / construction of the Santana system, left bank, and other irrigation systems,
- Total canal length for main, lateral, distribution and field canals : 900 km for 20,000 ha in total

Night Storage Ponds

System	Area (ha)	Total capacity of ponds ($x10^3m^3$)	Nos. of ponds	Volume of earthwork ($x10^3m^3$)
Santana	12,000	580	17	640
Left bank	5,800	340	10	370
Other area	2,200	110	4	150
Total	20,000	1,030	31	1,160

Note: Total capacity is estimated on the assumptions of the peak irrigation requirement of 1.1 l/s/ha and the operation time of 12 hours for releasing water from a pond.

(2) Galvan Groundwater Irrigation Project

Irrigation development is conceivable with the exploitation of groundwater resources in the Garvan area, although the groundwater availability must be made clear in advance.

The Project features are as follows:
- Objective area: about 540 ha,
- Provision of approximately 20 deep wells with pumps,
- Construction of distribution and field canals and
- Set-up and reinforcement of WUO.

(3) Yaque del Sur Small Gravity Irrigation System Improvement Project

This project consists of the improvement of small free intake irrigation systems along the Yaque del Sur River in the downstream reaches of the Guanito San Juan system, Villarpando headworks to Santana headworks and Vallejuelo irrigation system in San Juan.

The Project features are as follows:
- Objective area : about 7,500 ha,
- Installation of new intakes along the Yaque del Sur River ; 40 nos.,
- Improvement and/or construction of the access road to each of the intakes,
- Protection works against floods and
- Set-up and reinforcement of WUO.

4.5.6 Organization for Operation and Maintenance

(1) Irrigation District and Zone Office

As WUO is founded one by one in each of the irrigation systems, some of the INDRHI staff will be employed by WUO as technical and administration staff and INDRHI will commit WUO to carry out the operation and maintenance of irrigation and drainage facilities. Under such a situation, all the Irrigation District Offices will be reduced together with the zone offices in their volume of jobs. Major functions of the Irrigation District Offices will be concentrated on technical assistance and advice to WUO, construction supervision works, and large-scale repairing works.

(2) Water User's Organization (WUO)

The main objective of WUO is to operate and maintain the irrigation and drainage facilities by farmers' themselves in order to effectively use the limited water resources and to increase the agricultural productivity. The members of WUO are the water users of the irrigation systems, and its membership will be given to them irrespective of their gender.

The organization of WUO will be basically similar to the present organization of the Sabaneta Dam Irrigation Committee. WUO will have an organization structure of member farmers corresponding to the irrigation system level, which is generally as follows:

Nucleus : One distribution canal or a few field canals' level, 1 - 50 farmers, 20 ha to 60 ha

Sub-committee : One night storage pond, one pump irrigation system level, or one or a few small independent irrigation system level 50 - 500 farmers, 100 ha to 1,000 ha

Association : One large irrigation system, large lateral canal or a group of the small irrigation systems 500 - 1,000 farmers, 1000 ha to 10,000 ha Irrigation Committee One irrigation zone benefited by one river (Junta de Regantes)

In the existing WUO, the provision of night storage ponds will require the WUO to rearrange the organization structures to meet the requirements of the water management with night storage ponds.

WUO will employ technical and administration staff who will actually assist WUO in preparing maintenance programs, irrigation schedules and directly carry out O&M in the conveyance systems including the proposed night storage ponds, and to do the general affairs and administrative management including collection of water charges.

(3) O&M Facilities and Equipment

The Irrigation District Offices will assist WUO in large-scale repairing and maintenance works by construction equipment. The construction equipment is, therefore, maintained and replaced as usual. In addition, computer sets should be introduced in order to prepare and compile all the useful data and information and make the operation and maintenance programs.

WUO needs an office space, office furniture, computer sets, light trucks, motor bikes, and tools for the water management and routine operation and maintenance works. In the case of a large WUO, offices will be provided at each association level as a branch office in addition to a head office.

(4) Operation and Maintenance Cost

Considering the present consumption in the Irrigation District Office, it is estimated that WUO needs at least about DR$ 1,000 / ha.

(5) Irrigation Water Charge

In earlier years from the establishment of WUO, the water charges were able to be controlled at a low price by a subsidy from INDRHI so that farmers could easily pay it. Actually at present, the existing WUO has set the water charge based on its marginal or less than the costs for the O&M. All the O&M costs, however, should be covered by the irrigation water charges collected from the farmers in principle. Based on this principle,

the present water charge should be increased based on the understanding of WUO members as the irrigation system is improved.

In the amount of water consumed for a year, perennial crops and long-term growing crops such as plantain, banana, sugarcane and tree crops are almost the same as rice. Thus from the view point of water consumption, the water charge for such perennial or long-term growing crops should be the same as that for one crop season paddy. In case of the ordinary upland crops such as maize, beans, and tomato, the water charge will be reasonably a half of the paddy.

A nucleus chief will collect the water charges from the member farmers and pay the collected money into the bank account of WUO. This system is important from the view of the creation of joint responsibility among the members for paying the water charge. If a member or a nucleus does not pay the water charge on time, the money collector should be dispatched to them to collect the water charge. To achieve a good progress on collecting water charge, it is recommended to include some punishment and incentive in by-laws.

4.5.7 Operation and Maintenance Plan

(1) Operation

It is very important to prepare the cropping plan and seasonal irrigation schedule for the proper water management, since a series of irrigation systems from the heads to the field level are operated basically in accordance with the irrigation schedule. It is also essential that each of the farmers recognize how many hectares can be irrigated by the available water resources in his field before the planting season in order to avoid water dispute during water distribution. Thus the operation should be started from the preparation of the irrigation schedule in consideration of seasonal cropping plan and the available water resources. The proposed procedure to prepare the irrigation schedule is explained in detail in the Annex. Then based on the schedule, a water distribution schedule, which mentions the time and volume schedule of water delivery to every field plots, is prepared in each of the distribution systems or in each of the small irrigation systems by the irrigation sub-committees or nucleuses generally on a monthly basis.

At least once or twice during the cropping season, the WUO should investigate the kind of crops and the cropping area in the field and compile them at the irrigation system head level. Based on these data, the WUO or the Irrigation District Office should review the irrigation water demands and modify the seasonal irrigation schedule, if necessary and inform the Center. When a drought is expected, the Center should instruct the Irrigation District Office and WUO to modify the irrigation schedule and water distribution schedule in consideration of the decrease of the allocated amount of water. The crop sensitivity to the water shortage is also taken into account in the modification of the irrigation schedule.

In large-scale irrigation systems, water is continuously diverted from the river and conveyed through the conveyance system to the night storage ponds on a 24-hour basis. The intake gates should be operated to divert water in accordance with the irrigation schedule. When a flood occurs, the intake gates should be fully closed. The check and offtakes on the conveyance system are adjusted once or twice a month in accordance with the irrigation schedule. When a drought is expected, water released from the reservoirs is

reduced in order to prolong the stable water supply during the drought season. During in this time, a rotational water supply will be made among the irrigation systems and also among the lateral canals.

Water reaching a night storage pond is immediately stored in the night storage pond during the nighttime. In the morning, water is released from the pond to fields through a distribution canal system in accordance with the distribution schedule. It is important that distribution and field canals convey water to their full capacity during the daytime under the irrigation in each Nucleus block in order to maintain high irrigation efficiency.

In the case of small gravity irrigation systems, which are proposed to be improved with the provision of an intake gate, water should be diverted during the daytime only in order to effectively use water. The intake gate should be opened in the morning and closed in the evening. During the drought period when water resources are expected to be insufficient against the basin water demands, a rotational water supply will be made between the small irrigation systems located adjacent to each other.

(2) Maintenance

Small distribution and field canals will be maintained by the farmers themselves of every nucleus as communal work. The nucleus chief or representatives of member farmers will prepare a maintenance schedule for distribution canals containing an allotment of works to every farmer and the date of the works.

Major irrigation facilities such as headworks, main and lateral canals, the related structures, night storage ponds, and major drainage canals will be maintained by the staff employed by WUO with light equipment under WUO's responsibility. Large-scale repair works will be executed by the Irrigation District Office on an onerous contact basis based on the request of WUO.

4.5.8 Costs

The costs for the irrigation and drainage development projects mentioned in section from 4.5.3 to 4.5.7 are summarized in the following table:

Project Costs

Project	Project Area (ha)	Project Cost (DR$ million)
Development Plan in San Juan Area		
(1) Night Storage Pond Projects	20,961 (419.8)	841.5
(2) Guanito San Juan System Improvement Project	1,000	75.0
Development Plan in Azua Area		
(1) YSURA Area Improvement Project	7,732	459.0
(2) YSURA Extension Area Development Project	2,275	353.9
(3) YSURA Headrace Small Irrigation System Improvement Project	1,100	43.2
Development Plan in Lago Enriquillo and Yaque del Sur Areas		
(1) Yaque del Sur Lower Reaches Irrigation and Drainage Improvement Project	20,000	2426.8
(2) Yaque del Sur Small Gravity Irrigation System Improvement Project	7,500	382.1
(3) Galvan Groundwater Irrigation Project	540	65.5

4.6 Rural Infrastructure Development Plan

4.6.1 Rural Roads

Most of the rural roads are not sufficiently maintained in the Study area due to the lack of financial resources, badly affecting the transportation of the farm products especially in the rainy season. Since construction of canal inspection roads are planned along the major canals in the present study which will be utilized as farm roads, improvement of the roads linking these inspection roads and villages are considered to be the rural roads. Standard of the work includes repair of the impassable section, rehabilitation, additional pavement, shaping of unpaved roads and repair / installation of road related structures. Total length of rural road improvement is estimated below.

	Rehabilitation of rural road	Partially Improvement of rural road	Improvement of farm road
i) Azua province	20 km	108 km	48 km
ii) San Juan province	5 km	26 km	40 km
iii) Baboruco province	15 km	85 km	32 km
iv) Barahona province	0 km	29 km	24 km

Road construction and improvement for the coffee project and reforestation project as mentioned in Section 4.6 and 4.9 are estimated as follows.

	New Construction	Improvement of existing road	Improvement of existing footpath
Coffee project road			
i) Coffee pilot scheme	20 km	108 km	1 km
ii) Guayabar coffee scheme	-		14 km
iii) Monte Bonito coffee scheme	-	-	7 km
iv) Peralta coffee scheme	-	7 km	9 km
iv) Los Frios coffee scheme	14 km	3 km	-
iv) Aplonar Perdomo coffee scheme	-	4 km	8 km
Reforestation road	-	-	27 km

Supply of maintenance equipment is included for the Project in order to enable the local government to continuously maintain the farm road network. The responsible organization is assumed to be the district office of SEOPC. Maintenance equipment to be procured under the Project is estimated at bulldozer, backhoe, grader, dump truck, water tanker, macadam roller and their garages.

4.6.2 Rural Water Supply

The ratio of the rural water supply in the Study area is about 10% lower than the national average. In the Bahoruco province and the hilly areas in Azua and San Juan province, the ratio is especially worse worth. INAPA has various plans and projects for the development of the rural water supply, and the Projects are to be formulated within the framework of the national policy and INAPA program including the NGO's activities. In the present master plan study, a target is preliminary set up to achieve the point where the ratio of rural water supply catches up with the national average level, particularly in the depressed area. A location map of the proposed water supply project is shown in Figure 18.

	Present water supply coverage in 1993	Projected population in 2010	Existing INAPA design and plan	Target population coverage	Present master plan quantity	
					Tube well	Gravity
i) Azua province	64 %	463,000	3	13,300	0	4
ii) San Juan province	55 %	191,000	4	22,300	0	2
iii) Baboruco province	58 %	130,000	1	10,600	2	1
iv) Barahona province	76 %	153,000	2	4,000	1	0

4.6.3 Rural Electrification

In the present study, the preliminary study is made among the José Joaquin Puello and the Santana schemes listed on INDRHI's list and the Magueyal mini-hydropower scheme, of which the potential is reviewed in this study. The preliminary study indicated that the Magueyal scheme is considered promising in terms of power generation potential. For this scheme, a mini-hydropower station is planned to be constructed on the existing YSURA headrace utilizing the canal water taken at the Villarpando intake for power generation. After power generation, tail water flows to the tributary of the Yaque del Sur River and finally returns to the Yaque del Sur River, not affecting the water distribution for the proposed irrigation projects. However, this scheme is proposed to carry out more detailed investigation including a topographic survey and geological study for early implementation. Its installation capacity and annual possible power generation is estimated at 2,600 kW and 22 GWh respectively. Results of the comparison study and their location map are shown in Table 14 and Figure 19.

4.6.4 Other Social Infrastructure

For the present study on the river basin agricultural development, construction of the community hall and water user's office are proposed in connection with the proposed agricultural development and the strengthening of water users' activities in the irrigation area. Proposed facilities to be constructed in each area are shown as follows.

	Azua	San Juan	Baboruco	Barahona
1) Community hall	9	3	3	4
2) Water User's Office	4	0	2	1

4.6.5 Costs

Project implementation cost for the above rural infrastructure development is summarized below.

Project	Direct Construction Cost (million DR$)
Road improvement project	
- Rural road improvement	217
- Coffee road and reforestation road (Cost is included in the respective projects)	(33)
- Supply of maintenance equipment	140
Rural water supply	
- Water supply system by groundwater	67
- Water supply system by surface water	48
Supporting facilities	198
Mini-hydropower project	
- Magueyal mini-hydropower project	250

4.7 Water Demand and Water Balance in the Yaque del Sur Basin

4.7.1 Water Demand and Water Balance in the Yaque del Sur Basin

(1) Irrigation Water

Irrigation water demands were estimated in Sub-section 4.5.1 based on the with-project conditions, namely, enhanced irrigation efficiencies by improvement of irrigation facilities and proposed cropping patterns. Results of the calculation are summarized in Table 15.

(2) Municipal Water

The program does not envisage a long-term development plan and the design capacity of the future municipal water supply has not been estimated in the river basin. Forecast of the municipal water demand consisting of potable water demand and industrial water demand is therefore simply estimated based on the present condition and applying the Projected population in 2010. Forecasted water demand is however considered to be negligibly small for the overall water balance study compared with the irrigation demand, and hence it is not accounted for in the water balance evaluation.

(3) River maintenance Flow

As mentioned in Sub-section 3.9.6, there is no regulation on river maintenance flow in the Dominican Republic. The river maintenance discharges, which are examined in Sub-section 3.9.6, is assumed as a proposed maintenance demand[6] here. The simulated discharges at the checkpoints are compared with the demands and the model will be adjusted so that the discharges exceed the river maintenance flow.

4.7.2 Water Balance

Based on the estimated water demands, water balance is examined in order to estimate irrigable area by irrigation system. The coefficients and structures of the water balance simulation model, which was established for the analysis of present water balance in the Study area, were used for the proposed conditions. The water balance was evaluated on the demand basis from downstream to upstream. According to the demands for the Azua and Barahona/Neiba blocks, sufficiency of the waters in the Sabana Yegua reservoir was evaluated to determine if the reservoir could accommodate the demands at 80 % reliability for 14 years from 1981 to 1994. If the waters were not enough, the irrigation areas were adjusted until the demands met the amount of available waters. The San Juan block is dealt with independently and the water balance is conducted comparing the demands and the available waters in the block and/or Sabaneta Dam.

Three types of irrigation areas were given in the study (Table 16 to 18). The first was the **present** irrigation areas which are reported in the statistics. The second was so called **irrigable** areas under present conditions with 80 % probability. The last was the irrigable areas under **future** (with-project) conditions with 80 % probability. [7]

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[6] 0.5 m³/sec for upstream of Palo Alto, 1.0 m³/sec for the downstream.

[7] It is not possible to irrigate the present irrigation area with 80 % probability under present conditions of facilities and operation. It is necessary to evaluate the irrigable area with 80 % probability under the present conditions to evaluate

The irrigable areas under present and proposed conditions by block are summarized below:

(Unit :ha)

Block	Present	Proposed
San Juan Irrigation District	23,997	36,144
Azua Irrigation District	16,162	23,863
Yaque del Sur and Lago Enriquillo Irrigation District	25,438	44,185
Total	65,597	104,192

4.8 Water Resources Development Plan

4.8.1 Basic Concept

The total volume of available water resources in the Study area is not sufficient for the present water demands as mentioned in the Sub-section 4.1.1. In other words, the present demands in the Study area have already exceeded the potential of the surface. Therefore, main concerns in the water resources development in the Study area are considered:

(1) To increase the volume of water in the Basin,

(2) To decrease losses in water use, and

(3) To use the available water several times, i.e., re-use of the water.

Since the potential of large scale water resources development is considered low, the purposes or concepts of the water resources development in the Study area should be "**how to decrease the losses in water use**", and "**how to re-use the limited waters**".

4.8.2 Water Resources Development Plan

(1) San Juan Area

(a) Mijo Dam Development Plan

The capacity is estimated at 9.5 MCM and 45 m high at the proposed dam site at Cativo. However, dam development is not recommended for irrigation purposes because of low economic viability due to low dam efficiency, high sedimentation rate and large flood discharge. The possible dam size is small compared with the catchment area, which makes the cost higher and project life shorter. Dam development for the drinking water supply for San Juan City might be a possible alternative.

(b) José Joaquin Puello Dam Development Plan

The capacity is estimated at 9.5 MCM with a dam height of 30 m. The sedimentation rate of 2.0 mm/km^2/year will bring 0.9 MCM of sediments for 50 years, which is 10 % of the storage volume. Taking into consideration these basic features of the proposed dam, the development of the José Joaquin Puello dam is worthy of a further feasibility study.

(c) Los Baos Dam Development Plan

Los Baos Dam Project was identified by INDRHI in the 1970's. The catchment area at the proposed dam site is 301 km^2, but runoff of the Los Baos River is observed to be very low. Further investigations on geology and hydrology are required to examine this phenomenon

(2) Azua Area

(a) Sabana Yegua Dam Rehabilitation Project

The water level of the Sabana Yegua reservoir is currently controlled at 386.0 m during the hurricane season due to insufficient capacity and structural problems on the spillways. The storage volume at the level of EL 386.0 m is about 200 MCM, which is 150 MCM less than that of EL 396.4 m, the maximum operation level. Thus the improvement of the spillways will bring a great benefit in terms of water resources development.

(c) Azua Valley Groundwater Development Project

In Azua Valley, groundwater is utilized extensively for irrigation purposes. In particular, in the extension area of the Ysura Canal System, where little water is available from the canal, large-scale "tomato" cultivation is being practiced using groundwater and drip irrigation system. The groundwater potential of the Project area is estimated at 50 to 75 MCM/year or 5,000 to 7,500 hectare meter per year. Considering the possible salt-water intrusion to the aquifer by over-exploitation, conjunctive use of groundwater and surface water seems to be an appropriate project approach in the area.

(3) Barahona/Neiba Area

(a) Neiba-Galvan Groundwater Development Project

It is well known that the Neiba area has few surface water resources exclusively available for the area. Accordingly, people's living also largely depends on the groundwater. The intensive development of groundwater for rural development and irrigation is required. The potential area of the groundwater development is limited along the foot of the alluvial fan along the Neiba-Galvan road, with a length of 15 km in from east to west and a width of 3 km. Cluster tubewells will be proposed in the area at certain intervals so that the tubewells do not intervene each other. The groundwater will be distributed by pipelines for small-scale irrigation or domestic uses.

(b) Monte Grande Dam Development Project

The Monte Grande Dam Project was identified as an alternative plan of Quita Coraza dam, which was not finally recommended mainly due to technical problems on geology, sedimentation, and so on. The total capacity of the reservoir is estimated at 70 MCM with a dam height of 60 m and a length of 1,000 m. Similar development constraints to those of Quita Coraza dam are expected such as high construction cost, high sedimentation rate, among others. No detailed survey or studies having been carried out yet, but a feasibility study and preliminary design are considered necessary.

(4) Studies for Future Projects

(a) Justification Study on Water Resources Development

A number of dam development projects have been identified in the Yaque del Sur River Basin, including the above mentioned projects, namely Mijo, Los Baos, and Monte Grande. Some of these projects have been studied on some technical aspects such as geology, land suitability of proposed irrigation areas, hydropower facilities, and so on. However, most of the identified projects have not been studied and cannot be evaluated without any basic features such as availability of water resources, geological conditions, topographic conditions, land use and suitability of the proposed irrigation area, and others.

It is necessary to evaluate these candidate projects and select several projects for further steps: (i) basic and physical investigations on geology, soil and land suitability in the proposed irrigation area, (ii) optimization of development scale based on the water balance simulations, (iii) project formulation, (iv) preliminary design and cost estimate, and (v) economic analysis for justifying the Projects.

(b) Rincon Lagoon Aquasphere Resource Study

Utilization of Rincon Lagoon as a reservoir is a promising alternative to irrigate a large area in the Neiba Valley. It is technically possible to extract excess waters from the Yaque del Sur River to the lagoon. However, some constraints on water quality and environment are pointed out. Monitoring water quality, water level, storage volume, etc., should be done in order to clarify the possibility of utilization of the Rincon Lagoon. The possibility is considered to have increased after observing changes in the aquaspheric environment such as water quality and volume, which were caused by Hurricane George during the Study period.

4.9 Plan of Environmental Conservation

4.9.1 Reforestation in the Upper Watershed Areas of Grande River

(1) Basic Concept

The most important concept in this plan is to change the local people's role, from the role of agents who cause deforestation to agents who create and manage forests. For this concept, participation of the local people in the Project is essential. Also empowerment of local people is one of the important concepts of the plan.

(2) Selection of Model Area and Schedule of the Plan

The selected area is along Arroyo Limon River, a tributary of the Grande River as shown in Figure 20. The area is around 3,000 ha in size. The grade of inclination is generally very high, from 32 to 40 degrees. Annual rainfall is 800 to 1,000mm. Several communities (paraje) exist in the area. In the plan period, about 5 years, the total reforested area will be 720 ha. The number of families participating will be 720.

(3) Improvement of Land Usage of Local People

Two programs, the Education and Training for Fire Control and Soil Conservation, and the Promotion of Sedentary Agriculture, are conducted to improve the land usage by local people.

(4) Reforestation Plan

To carry out the plan under the people's participation, the local people are organized and small groups as working units are formed. A group, which consists of around 60 families, works under the instruction of specialists from a consultant. The consultant works with a group for 3 months from the stage of land preparation to the seedling planting. After that, the consultant shifts to another group to continue the planting program. After 1 year, the consultant will have related with 4 groups.

Four nurseries will be constructed in the plan. The scale of a nursery is mentioned: The area of the nursery is 1,500 m^2 while plant production capacity is 300,000 seedlings/year; Facilities in the nursery include seed and seedling beds, irrigation system, hut for labor stay, and a shed. Plant species, which are adequate to plant in such zones, are: Pino (Pinus occidentalis), Pino (Pinus caribea), Caoba (Swietenia mahagoni), Cedro (Cedrela odorata), and others. The plan includes other programs, such as Improvement of Access Road, Education and Training, and Monitoring.

(5) Organization and Management

The headquarters of INDRHI works as a coordinator among various organizations relating to this plan, such as sponsors and other governmental organizations. Some site coordinators from INDRHI always stay at a local office in Bohechio. They work as a coordinator between the consultant, headquarters of INDRHI and the organization of local people. The consultant director relates with the local people to implement the plan. He works as coordinator between the organization of local people and the INDRHI, and also provides education and training to the local people. A group of local people consists of 60 families. The group actually works to implement the planting and management of. It also serves as a unit to receive education and training courses from the consultant.

(6) Costs

The total plan cost is estimated to be 14,958,090 DR$.

4.9.2 Wildlife Conservation in Rincon Lagoon

(1) Basic Monitoring Study of Fauna and Flora in Rincon Lagoon

The total study period is 10 years. In the first half of the first year, a general study to understand the condition of the fauna and flora is conducted. After the study, from the second half of the first year until the tenth year, periodical studies focusing on a bio-indicator are carried out every two months. The object area of the study is the whole area of the lagoon. The items of the general study are: Description of Fauna and Flora and their Quantity, Drawing of Vegetation Map, Condition of Ecosystem, Measurement of Water Level and Topography of Bottom of Lagoon, and Water Quality of the Lagoon.

The periodical study is conducted to monitor the condition of fauna and flora and to understand the relation between the water fluctuation and its impact for livings in the lagoon. In the survey, some bio-indicators and areas selected from the result of the general study are focused. The study method will be made after the analysis of the result of the general study.

As the result of analysis and evaluation of the data, some recommendations concerning water condition for wildlife conservation are made. Water introduction from the Yaque del Sur River to the lagoon may be one of topics of the recommendations.

(2) Necessary Equipment and Facilities

The facilities required are huts to observe the fauna and to stay overnight, several boats with motors, and a 4-wheeled vehicle. Necessary equipment for the survey are some binoculars and a 40-power telescope.

(3) Organization and Management

The Sub-secretariat of Natural Resources (SURENA) and National Direction of Parks (PARQUE) are the main organizations to coordinate and manage the plan. A consultant conducts implementation of the field survey and the analysis. The INDRHI and academic researchers work as academic and technical advisor to the consultant.

(4) Costs

The total plan cost is estimated to be 4,561,680 DR$.

4.10 Initial Environment Examination (IEE)

4.10.1 Basic Concept

In this study, 26 proposed projects in total are listed. The IEE on all projects is conducted using the checklist. As a result of the IEE, some considerable impacts are foreseen, and implementation of the EIA in the feasibility study will be necessary.

4.10.2 Environmental Impacts and Results of IEE

As a result of the IEE, the implementation of the EIA is required for the 3 projects as follows. The summary of the IEE result is shown in the next table.

(1) Improvement of Irrigation and Drainage System in the Lower Reaches Systems of the Yaque del Sur River

A considerable impact of the Project is soil salinization. By the improvement of drainage canal networks to remove salt contained in the soil layer and to maintain the salt content low, drainage water will contain much more salt than before. The salt would accumulate in another place. Also the lifestyle change of local people should be taken into consideration. The establishment of the water user's organization will cause changes in the social system of the community. From the viewpoint of project implementation, the evaluation of the social environment of the community regarding social structure, education

level, and leadership is important to function the organization.

(2) Jose Joaquin Puello Dam Development Plan

Considerable impacts of the plan are deforestation and erosion and degradation of soil. Some bush areas will be inundated by the reservoir. Soil erosion in the watershed area will cause sedimentation in the reservoir. There is no agricultural land nor residents, so disturbance of farm and resettlement will not occur.

(3) Galvan Groundwater Irrigation Project

Considerable impacts are soil salinization and the change of groundwater level. In the Project area, the problem of soil salinization is observed. The project will cause the groundwater to rise which often becomes a trigger of soil salinization.

Table Summary of IEE Result

Environmental Impacts		Proposed Project	1)YSURA Extension Area Development Project	2)Nidal Storage Pond Project	3)Guanito San Juan Irrigation System Improvement Project	4)YSURA Area Irrigation System Improvement Project	5)YSURA Headrace Small Irrigation System Improvement Project	6)Yegua del Sur Small Gravity Irrigation System Improvement Project	7)Yegua del Sur Lower Reaches Irrigation and Drainage Project	8)Sabana Yegua Dam Rehabilitation Project	9)Jose Joaquin Puello Dam Development Plan	10)Galvan Groundwater Development Project	11)Galvan Groundwater Irrigation Project	12)Azua Groundwater Development Project	13)Plan of Villarpando Water Management Project	14)Magueyal Mini-Hydropower Project	15)Rural Water Supply Plan	16)Other Social Infrastructure Improvement Plan	17)Rural Road Improvement Plan	18)Plan for Agricultural Cooperatives	19)Plan for Seed Multiplication	20)Plan for Credit Services	21)Plan for Marketing Information System	22)Plan for Strengthening CIAZA Research Center	23)Coffee Production Improvement Project	24)Strengthening Extension Services	25)Reforestation in the Upper Watershed Areas of Yuna River	26)Wildlife Conservation in Rincon Lagoon
Natural Environment	Deforestation	D	D	D	D	D	D	D	D	A	D	D	D	D	B	B	D	D	D	D	D	D	D	C	P	D
	Erosion and Degradation of Soil	D	D	D	D	D	D	D	D	A	D	D	D	D	D	D	D	D	D	D	D	D	D	D	P	D
	Soil Salinization	C	C	C	C	C	D	A	D	D	D	A	C	D	D	D	D	D	D	D	D	D	D	D	D	D
	Loss of Biodiversity and Wildlife	D	D	D	D	D	D	D	D	B	D	D	D	D	D	D	D	D	D	D	D	D	D	D	P	P
	Change of Grandwater Level	C	C	C	C	C	D	C	D	D	D	A	C	D	D	D	D	D	D	D	D	D	D	D	D	D
	Intrusion of Seawater	D	D	D	D	D	D	D	D	D	D	D	C	D	D	D	D	D	D	D	D	D	D	D	D	D
	Environmental Pollution esp. Water Pollution	D	D	D	D	D	D	C	C	B	D	D	C	C	C	D	D	C	D	D	D	D	D	C	C	D
	Increase of Agrochemical and Fertilizer Use	B	D	D	D	D	D	B	D	D	D	B	D	D	D	D	D	D	D	E	D	D	D	B	D	D
Social Environment	Health and Water Born Diseases	C	C	C	C	D	D	C	D	B	E	B	B	D	D	D	D	D	D	D	D	D	D	D	D	D
	Water Rights	C	C	C	C	D	B	C	D	E	C	B	B	C	D	D	D	D	D	D	D	D	D	D	D	D
	Resettlement	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
	Disturbance of Farms	C	C	C	C	C	C	C	D	C	D	C	D	D	C	D	D	D	D	D	D	D	D	D	D	D
	Change of Lifestyle of Local People	D	D	D	D	D	D	C	D	D	D	D	D	D	D	P	P	P	C	D	C	D	D	D	P	D
	Gender	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	E	D	D	D	D	E	E	D
	Degradation of Landscapes	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
EIA is Required or Not?		×	×	×	×	×	×	○	×	○	×	○	×	×	×	×	×	×	×	×	×	×	×	×	×	×

A: Serious environmental impact is expected, B:Small environmental impact is expected, C: Although environmental impact is expected, it will be reduced by countermeasures,
D: No environmental impact is expected, E: Unknown, P: Positive impact is expected

4.11 Action Plan

4.11.1 General

In the master plan, 27 projects have been formulated. One project is for the agricultural development, 6 projects for agricultural support services, one project for overall water management in the Yaque del Sur River Basin, 9 projects for irrigation and drainage development including strengthening water users associations, 4 projects for rural infrastructure development, 2 projects for environmental conservation and 4 projects for water resources development. The master plan is formulated as a 10-year plan up to the year of 2010. These projects are co-related and should be executed in an efficient way through proper combination and appropriate scheduling. The implementation of phases and priorities of the Projects are proposed in the action plan. Salient features of these projects are summarized in Table 19 and location of these projects is shown in a general map.

4.11.2 Project Assessment and Implementation Schedule

For the Project evaluation for these projects, benefits and costs are estimated as shown in Table 19. Benefits of agriculture, irrigation and drainage projects are estimated as the difference in farm profit from crops between the future with-project and without-project conditions. Farm gate prices of farm inputs and outputs in the Study area in 1998 were used in the evaluation. With respect to credit services and seed multiplication plans, internal rate of return is calculated for assessment. For the Projects related to other agricultural support services, overall water management, rural infrastructure, environment and water resources, benefits are not calculated. Costs of these projects are estimated based in the market prices of 1998 in the Dominican Republic. The exchange rate used in the cost estimate was 14 Dominican Pesos = one US$. Shadow wage rate and standard conversion factors for costs are not used for economic evaluation in this study. Under such conditions, the agriculture and irrigation/drainage projects are economically evaluated by the internal rate of return. Other projects are not economically evaluated. All projects are preliminarily assessed in view of environmental and social impacts. Details are shown in the Action Plan in Annex-I. As a result, the implementation schedule of these projects in each sector is illustrated in Figure 21.