3.8 ENVIRONMENTAL ASPECTS

3.8.1 General

In the Dominican Republic, several environmental problems have appeared especially in these decades, and some of them severely affect the citizen's life. To minimize the degradation of environmental condition, the environmental consideration in development projects is accurately required.

For the environmental consideration, in this study of the master plan level, the Initial Environmental Examination (IEE) is conducted in section 4.10..

To conduct the IEE, in this session some basic information concerning environmental issues, such as the present environmental problems, organizations and laws, and environmental projects, are firstly explained, and then the IEE is conducted in section 4.10

3.8.2 Environmental Conditions and Problems in the Study area

(1) Environmental Conditions and Problems Observed

In the country, principal environmental problems are mentioned below:

(a) Deforestation,
(b) Erosion and Degradation of Soil (including soil salinization),
(c) Loss of Biodiversity and Wildlife,
(d) Environmental Pollution (especially water pollution), and
(e) Degradation of Ecosystem in Marine and Coastal Areas.

Among these problems, (a), (b), (c) and (d) are pointed out as critical problems in the Study area. The condition of the each problem is explained below.

(a) 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 reducing as indicated next : 33,000 km^2 (69%) in 1945; 12,500 km^2 (26%) in 1962; 8,710 km^2 (18%) in 1980 ;and 6,232km^2 (13%) in 1987 (FAO's study in corresponding year).

In the Study area, the forest areas mainly consist of the coniferous forest and dry forest whose areas are 840 km^2 (12%) and1,750 Km^2 (25%) correspondingly (see Fig. 3.3.1). There are several causes of deforestation in the area as follows:

(i) Until 1960s the main factor of deforestation in coniferous forests was commercial logging. The timber was used for the house and building construction and furniture making. In 1968, the timber logging was prohibited by a law.

(ii) After 1970s until today, small farmers have practiced the shifting cultivation. They cut forest and burn to make a farm, and sometimes forest fire expands to large area around the farm.

(iii) In some areas, pastures are developed in the abandoned farms after the shifting cultivation had been practiced. In this case, the land is covered with only grass. As shown in Fig. 3.3.1, a large part of the upper area of watersheds, for example of San Juan River, Las Cuevas River and Grande River, is covered with natural pasture.

(iv) In the dry forests, the main factors of deforestation are fire wood collection and charcoal making by local people. But, recently, the amount of the charcoal production have been reduced, while the gas usage for cooking has been becoming popular.

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

Erosion and degradation of soil seriously affect agricultural productions and sedimentation in reservoirs. For example, according to the results of the AID project located in the Las Cuevas river basin in the upper area of the Sabana Yegua Dam, it is estimated that, in the area of 5,690 ha, 275 tons/ha/year or the top soil with 1.83cm/year are eroded out.(Perfil Ambiental del Pais; 1981).

As examples of sedimentation in reservoirs in the Study area, in the case of Sabaneta Dam, according to the study in 1992, the volume of sedimentation is estimated at 10,931,950 m3 which corresponds to 2.0 mm/year/km2 of soil layer loss of the watershed (Batimetria Embalse de Sabaneta Febrero de 1992). In the case of the Sabana Yegua Dam, according to the study in 1992, the volume of sedimentation is estimated at 57,616,000 m3 which corresponds to 2.6 mm/year/km2 (Batimetria Embalse de Sabana Yegua Deciembre de 1992).

The main causes of the soil erosion are deforestation and also the farming systems without proper soil management. The slope of the Cordillera Central distributed in the northern part of the Study area are largely covered with the natural pastures, as a deforested area, and with the extensive agriculture lands, as a poor soil management area.

In the area where irrigation and drainage are improperly practiced, a problem of soil salinization is observed. In the Study area, the problem is found in a part of Azua, San Juan valley and Neyba valley.

(c) 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 the human activities. Although the present condition of biodiversity and wildlife is not completely understood, some endangered species such as iguana, marine torture, and

crocodile are found. The number of such species is reducing because of commercial hunting.

The function of the 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 (see Fig. 3.8.1). Based on Planning Department, National Direction of Parks and the National Parks of the Dominican Republic (1989), their characteristics are described below (The specie name is described in Spanish and scientific name in parentheses).

(i) Jose del Carmen Ramirez National Park

It is located on the southern slope of the Cordillera Central and is 764 km^2 large. It was created in 1958. It is mainly covered with coniferous forest, broad leaf forest, and mixed forest. Some conspicuous species of flora in the park are: Sabina (Juniperus gracilior), Cigua Blanca(Mectandra coriaceae), Caracoli (Lysiloma latisiliqua), Cedro (Cedrela odorata), Guarana (Cupania americana), Palo de Viento (Didymopanax tremulun), Palma de Manacla (Prestoea montana), Palo de Cotorra (Brumellia Comocladifolia), Amacey (Tetragastris balsamifera), and Abey (Pithecelobium arboreum). On the other hand, some important speices of fauna are: Jutia (Plagiodonitia aedieum), La Cotorra (Amazona ventralis), Canario (Carduelis dominicensis), Judio (Crotophaga ani), Guaraguao (Buteo jamaicensis), Perdiz (Geotrygon montana), Carpintero (Melanerpes striatus), Ruisenor (Mimus poliglotos), and Tortola (Zenaida macroura).

(ii) Valle Nuevo National Park

It is located in the middle of the Cordillera Central and it is 409 km2 large. The Nizao and Yuna rivers rise from the park area. It is mainly covered with grandes oinaares (Pinus occidentalis) and presencia de eb ano verde (Magnolia palencens) which is a endemic species of the island. Cnoncerning fauna, 66 species of birds are reported, in which endemic species and 20 endangered species are included. Also 19 species of mammalia with 2 endangered species and 2 endemic species, are found.

(iii) Sierra de Neyba National Park

It is extended in the direction of Northeast-Southwest between the Lago Enriquillo and the San Juan valley. The forests of Swietenia mahagoni and Coccoloba diversifolia are basically distributed between 400 and 900 meter above sea level, and the mist forests which mainly consist of Didymopanax tremulus and Podocarpus aristulatus are distributed in the higher part. Concerning avifauna, 83 species are found, in which 21 species are endemic and 19 species are endangered. Also 8 species of mammals exist.

(iv) Sierra Martin Garcia National Park

It is located between Azua and Barahona province. 4 mangrove species are found in Neyba Gulf. The species are mangle rojo (Rhizophora mangle), mangle prieto (Avicennia germinans), mangle blanco (Laguncularia racemosa) and mangle boton (Conocarpus erecta). Some species existed in dry area are bayahonda (Prosopis juliflora), alpargata (Consolea monififormis) and caguey (Neoabotia paniculata) Concerning avifauna, 67 species are reported, in which 14 species are migratory and 11 species are endemic. In the park, El Cafe Lagoon is the interesting place for biodiversity of aquatic livings.

(v) Laguna Cabral o Rincon National Park

It is the second largest lagoon and the largest fresh water lagoon of the country. The Park is 47 km^2 large. The water flora consists of Loto (Nelumbo lutea), Lila de Agua (Nymphaea spp.), Yerba de Hicotea (Nymphaea ampla), and Yerba de Cotorra (Ceratophyllum demersum). The marine fauna is represented by Camaroncito de Rio (Palaemon pandaliformis) as well as various endemic fish species, e.g. Limia and Gambusia. The largest population of Hicotea (Trachemys decorata), which are endemic of the island is found. The following bird speices have been reported on and around the lagoon: Pato Cripllo (Oxyura dominicana), Pato Espinoso (Oxyura jamaicensis), Flamenco (Phoenicopterus ruber), Garza Pechiblanco (Hydranassa tricolor), Coco Oscuro (Plegadis falcinellus), Pato de la Florida (Anas discos), Gallinuela (Porzana carolina), and Gallito Prieto (Jacana spinosa).

(vi) Hoya de Enriquillo National Park

The park includes lake and islands. Some dominant species of flora are: Alpargata (Consolea moliniformis), Cayuco (Cereus morniformis), Guasabara (Cylindropuntia caribaes), and so on. In fauna, endemic species are Iguanas Ciclura and Cyclura ricordi, while some speices of avifauna are Flamencos, Cucharetas, Madam Zagas, etc.

(d) Environmental Pollution (especially water pollution)

The problem of environmental pollution has become critical as the growth of urban areas and industrial sectors. Especially the water quality of the rivers which pass through in urban areas is not favorable for the living use.

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

Herbicide: Propanil, 2-4-D, Gramoxone

Insecticide: Karate, Decis, Nuvacron, Cymbush, Sumithion, Sistemin, Thionex
Fungicida: Dithane M-45
Raticida: Warfarina
Fertilizer: Formula 15-15-15, Urea, Sulfato de Amonio

(2) Comparatively Minor Environmental Problems

The environmental problems in regional level, and some problems strongly related to agricultural projects are considered as mentioned below.

(a) Health and Water Born Diseases

Related with agricultural projects, if water areas increase, it is possible to increase the case of the water born diseases, such as diarrhea, malaria, typhus and dengue fever. In the Study area, there are many cases of hospitalization because of the acute diarrhea and typhus as shown in the following table.

Table Cases of Hospitalization Because of Water Born Diseases

areas	Barahona	Bahoruco	Azua	San Juan
Acute Diarrhea	1,974	571	3,095	2,839
Typhus	53	112	320	214
Total	2,027	683	3,415	3,053

Source: Memoria Anual Salud Publica 1996 (1997)

(b) Water Rights

At present, many cases of water use without water rights are observed in the Study area. Also related to agricultural projects, it is possible to occur some problems 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 new irrigated area and the resettlement projects by the IAD are observed. By a resettlement project, the community would be affected, for example social and cultural change of the community system.

(d) Gender

Especially in the rural areas, it is considered that the sexual inequality is observed. For example, women have a few chance of participation for social activities. At present, some NGOs, such as the MUDE (Mujers en Desarrollo Dominicana, Inc.), are working to help the women's activities.

3.8.3 Organizations in Charge of Environmental Management and Relevant Laws/Regulations

(1) Organizations

There is not a integrated governmental organization to handle the environmental issues, but several relevant organizations exist. The principal organizations are mentioned below:

(a) Department of Environment, National Planning Office (ONAPLAN)

The department was originally established in 1965 as the Department of Environmental Planning. The main functions of the department are to draw up the environmental plans nationwide and to coordinate the several organizations for a project carried out under multiple organizations. At present, the department has 2 divisions: Environmental Protection and Natural Resources.

(b) Sub-secretariat of Natural Resources (SURENA), (SEA)

The sub-secretariat was established in 1965 for the purpose of the conservation of and study about the natural resources, and the environmental education. At present, there are 5 departments and 1 section as follows:

- Department of Natural Resource Inventory,
- Department of Wildlife,
- Department of Fishery Resources,
- Department of Lands and Waters,
- Department of Environmental Education, and
- Regional Sections of Natural Resources.

(c) General Direction of Forest (FORESTA)

The Direction was originally established in 1962 under SEA and then was moved to under State Secretary of Defense. Main purposes of the organization are now the protection and watching of the forest areas, afforestation, and training for forestry technicians.

(d) National Commission of Forest Technology (CONATEF)

The Commission was established in 1982 by experts from the SEA, INDRHI, FORESTA, and PARQUE. The functions of the Commission are forest policy making and the supervision of forest use, such as logging and sawing.

(e) National Direction of Parks (PARQUE)

This Direction was established in 1976. The functions are development, management, supervision, and maintenance of the National Parks and Reserves.

(f) Office of Watershed Management, INDRHI

The Office was established in 1991 as a program in Planning Department, INDRHI and in 1997 it became the office. At present, there are mainly 5 projects

relating to watershed management and, in the Study area, one of them is conducted in Las Cuevas watershed. Main components of the projects are afforestation involving local people and environmental education to them.

(g) Others

Besides the above mentioned governmental organizations, there are many non-governmental organizations (NGOs) of regional, national and international level. Some NGOs are conducting environmental projects with the governmental organizations and international organizations.

(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 that at the present there is no integrated law about environment. So far there are several laws and regulations relating to the environment problems mentioned in 3.8.2, which are:

(a) Law 5856 (April 2, 1962)

The law concerns the conservation, restoration, and utilization of forest vegetation, and also development and adequate integration of the forest industry. A strict forest conservation policy is declared, and the General Direction of Forest was created under the SEA by this law.

(b) Law 5914 (May 22, 1962)

The law concerns conservation of marine resources and promotion of fish breeding. It regulates the fishing and capture of nolluse and crustacean in all the water in the country.

(c) Law 627 (May 28, 1967)

The law declares national interest of the use, protection, and acquisition of the all or a part of the lands in the mountain ranges.

(d) Law 123 (May 19, 1972)

All concessions and permits until then for the extraction, remove and dredging of sand, soil and stone were canceled, and new permission from the commission to be established by this law must be obtained.

(e) Law 67 (Nov. 8, 1974)

The law concerns the national park. The National Direction of Parks was established as an autonomous organization with legal personality in order to develop, manage, organize and take care of recreative, historic and natural areas.

(f) Law 632 (May 22, 1977)

The law concerns the prohibition of tree cutting in the river heads in the area with a radius of 1/2 km.

(g) Law 295 (August 28, 1985)

The law declares the high national interest to the nation's natural resources. It includes natural education programs.

3.8.4 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:

(1) National Plan Quisquella Verde

The plan started in 1997 under the Technical Secretariat of President. Its main objective is reforestation of the national territory. Also the environmental education, and the generation of employment are important roles of the plan. The actual projects are practiced by the organizations, such as INDRHI, SEA, FORESTA, PARQUE, and NGOs, while the Quisquella Verde plans and manages the programs, and coordinates and supervises the organizations. In the Study area, a project is carried out in Las Cuevas watershed.

(2) PRODAS (Agricultural Development Program in San Juan de la Maguana)

Although the PRODAS is basically a project for agricultural development, funded by the BID and the INDRHI, it includes some components of afforestation and rural development. The Project includes 6 sub-projects as described below:

(a) Afforestation in upper area of San Juan River

The purpose of the sub-project is the recovery of forest resources and watershed condition, and the decrease of erosion and sedimentation. 1,850 ha of afforestation is the target of the project. It is conducted by EYCA-ENDA CARIBE, a NGO, and its total fund is US$10,360.

(b) Protection of Jose del Carmen Ramirez National Park

The purpose of the sub-project is the conservation of the National Park and, construction and maintenance on infrastructure in the park. The project is conducted by National Direction of Parks, and its total fund is US$254,000.

(c) Construction of small scale infrastructures in rural communities

To improve the living standard of around 55,200 peoples in mid area of the watershed, the construction and improvement of small scale infrastructure such as small scale irrigation, roads between communities, water supply, and toilets will be done.

(d) Agro-forestry

Objecting to around 3,300 families of communities in the mid of the watershed area, the agro-forestry system is introduced. The project is conducted by several NGOs.

(e) Regularization of land management

The titles of 2,340 pieces of land will be distributed to small peasants through this project.

(3) Reforestation Project in Rio Las Cuevas

The INDRHI has carried out the project from 1997. Some parts of the fund come from the Quisqella Verde. In the upper area of the Sabana-Yegua Dam, a large area of deforestation which causes a big amount of soil erosion and then the sedimentation to the reservoir is observed. In this project which involves the local people, trees are planted by themselves. In 1997, 2,500 tareas were planted, and according to the plan, until 2000, 10,000 tareas will be afforestated.

(4) Project Rational Management of Dry Forest

This project has been realized from 1986 by the Institute for Development of Southeast (INDESUR) with cooperation of the GTZ. The purposes of the project are the recovery of the dry forest and the improvement of living standard of the local people in the all area of the southeast, 500,000 ha and with around 1,800 families. The project has 4 components, which are:

(a) Organization of the peasants,
(b) Direct commercialization of products to the regional markets and the capital,
(c) Development and application of rational management of forest with peasants, and
(d) Transfer of land title to peasant's associations.

(5) Management of National Parks

The National Direction of Parks (PARQUE) has conducted 2 projects to make management plan of national parks in the Study area, which are:

(a) Madre de las Aguas

This is a project for the master plan making for 4 national parks and a reserve area which are situated in the Cordillera Central.

(b) Project for Protection of the Rincon Lagoon

This project was conducted from 1996 to 1997 by the SURENA of the SEA and the PARQUE with financial cooperation of GTZ. Mainly a socio-economic survey was done.

(6) Some Programs by NGOs

In the Study area, there are various projects concerning the environmental conservation by NGOs. Some of them are:

(a) Protection of the Biodiversity of Ecosystem in Sierra Neyba

The project is carried out by the Health and Welfare Foundation (FUSABI) with the funds from the GEF (Global Environment Fund). The project period is for 2 years from 1997. Main project components are field study and investigation to identify the biodiversity condition and reforestation.

(b) Protection of Fauna and Flora in Rincon Lagoon

The project is conducted by the Ecological Society of Cabral (SOECA). The project components are education, evaluation of natural resources, reforestation and identification of the fauna and flora.

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 play a great role in the water supply. The main source of the river water is, needless to say, rainfall, but the runoff of the Yaque del Sur River greatly depends on artificial factors. They are; i) operation of the two dams whose catchments occupy nearly half of the total river basin, ii) large irrigation area which retards the runoff, iii) irrigation operation including trans-basin water distribution, etc.

Thus the key issues or purposes of the water balance in the Study are considered as follows:

- To evaluate available water resource and demands quantitatively and clarify the sufficiency
- To grasp the actual operations of facilities in comparison with simulated and actual values.
- To provide feed-back information for re-evaluating of parameters, such as irrigation efficiency, irrigated area, return flow rate, runoff coefficient, etc
- To clarify the determinative factors on the operation of facilities
- To point out the systematic problems and constraints on the present operations
- To suggest realistic and practical countermeasures to enhance the water use efficiency

Groundwater is not included in the inter-basin water balance, because the groundwater is utilized at certain points independently. Industrial and domestic water demand are not included, either, because of their small and constant demands. They will be separately evaluated.

3.9.2 Water Right

(1) Law on the 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.

"The Law No. 5852, on Domain of Surface Waters and Distribution of Public Waters" gives details on the usage of waters including subterranean waters available in the country.

According to the Law, the waters which come up in any form (rainfall, spring, groundwater) within private-owned lands belong to the owners as far as they remain in the lands. Other waters, in any form, in the public domain can be used only by the ones that are given water rights to use them.

Regarding the authorization, it is described in the Article 4 of the Law as follows:
"The Secretariat of State of Agriculture through the Directorate General of Hydraulic Resources[11] may grant authorization to whoever so requests, to construct on public lands cisterns or reservoirs wherein they may collect rain water."

In Chapter IV of the Law, application procedures for use of water are mentioned. The title holders must request and obtain permits from the Directorate General of Hydraulic Resources and renew their permits every year from the 1st to the 30th of November by paying the due charges for water use.

The charges for the applications for the titles of water on irrigation are given in the Article 61:

- For the title to waters for purposes of irrigation up to 5 lit./sec or less RD$ 2.00
- For additional liter RD$ 1.00 up to a maximum of RD$ 25.00
- For titles of waters for installation of pumps for irrigation purposes RD$ 25.00

It is also mentioned in the Article on the irrigation water supply as follows:
"In irrigation locations where there can be applied the system of measure by liters, one liter per second per hectare will be considered for normal irrigation, and two liters per second per hectare for irrigation of rice.

(2) Water Right by Canal in the Study Area

INDRHI registers and entitles the water right to each user every year by 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:

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[11] : The former organization of which functions were entrusted to INDRHI in 1962.

Zone	No. of users	Area (ha)	Unit Charge (RD$/ha)
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 given in Table 3.9.1 and summarized below:

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

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

3.9.3 Potential Water Resources

(1) Surface Water

Potential surface water resources at certain points consist of three factors, i.e., i) direct rainfall to the benefited area, in other word "effective rainfall", ii) water body on the ground as a source such as rivers, drains, lakes, ponds, etc., and iii) re-use of these waters. In the water balance study, which is described in the Sub-section 3.9.6, these three components are evaluated synthetically. The total volume of surface water at the proposed intake site is mentioned here.

In the course of the evaluation, the Study area was divided into four 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 irrigation district Block, iii) Yaque del Sur irrigation district Block, and iv) Lago Enriquillo irrigation district Block. Present water distribution system in the Study area is illustrated in Fig. 3.9.1.

(a) San Juan irrigation district Block

The main water source of San Juan Block is the San Juan River or Sabaneta Dam. The Mijo River is the second water resource in terms of runoff volume, of which runoff is big compared with its catchment area[12]. On the contrary, the Los Baos River, of which catchment area is 335 km^2 at the Vallejuelo headworks has very small runoff.

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

[12]: 161 km^2 at the Mijo headworks.

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)[13]

(b) Azua irrigation district Block

Azua irrigation district 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 waters from the sources are diverted by the Villarpando headworks which are located at the confluence of the two rivers, with a catchment of 3,720 km^2. The runoff at Sabana Alta and Sabana Yegua is considered to be the water source for the Azua Irrigation System, and Lago Enriquillo/Yaque del Sur irrigation Block as well.

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) Yaque del Sur irrigation Block

Located on the downmost reach of the Yaque del Sur River, Yaque del Sur irrigation 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 below:

[13]: Figures for the Mijo and the Los Baos River are based on the actual records. Those for Sabaneta Dam and Sabana Alta were partly estimated for the missing periods.

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)

(d) Lago Enriquillo irrigation Block

Lago Enriquillo irrigation Block has no major surface water source. The main surface water sources are; i) the drained water from the Santana Irrigation System and Rincon Lake. According to the simulation carried out in this study, the drained water from the Santana System was estimated at 64.5 MCM/year[14] on the average, which is equivalent to 2.0 m^3/sec.

In the flanks of the Neyba Mountain Range (Sierra de Neyba), there exist some small streams such as the Majagual River, the Panzo River, and the Manguito River. On the use of these water sources, following difficulties and constraints are expected:

- A large amount of the waters infiltrates into the ground at the top of the alluvial fans, and recharges the groundwaters which are used along Neyba-Galvan area,
- The runoff is erratic and small in volume, and
- The proposed intake sites are located far from the irrigation area.

Thus, the possibility of utilization of the surface waters here for the irrigation purpose is considered very low.

Details of the surface water availability at each irrigation system is described in the Sub-section 3.9.6, "Present Overall Water Balance in the River Basin".

(2) Groundwater

As mentioned in the Sub-section 3.2.3, the Study area belongs to four "hydro-geological zones". They are; i) San Juan Valley, ii) Neyba Mountain Range, iii) Neyba Valley, and iv) Azua Valley. Groundwater potential evaluated based on the previous studies is described in the following.

(a) San Juan Valley

Few detailed investigations on groundwater potential have been carried out in the San Juan Valley, and the groundwater potential has not been clarified, either. In the

[14] : A rate of 20 % was assumed as "return flow rate" from the Santana Irrigation System. (Refer to Sub-section 3.9.6).

report of PLANIACAS[15], it is mentioned that the groundwater potential in the whole Valley amounts to some ***50 MCM/year***. This volume was estimated by a groundwater recharge rate of 150 mm/year, while assumed total annual rainfall was 800 mm. Considering that the physical conditions which affect the hydro-geological status seem to have changed little since in the PLANIACAS Study, the groundwater potential itself might be considered similar at present. Further hydro-geological investigations are necessary to evaluate the potential at certain locations, but the groundwater potential in the Study area is not considered very high compared with the surface water. Accordingly, the groundwater is considered to be a water source for domestic or supplemental irrigation purpose in the areas, which can not be covered by the surface water distribution systems.

(b) Neyba Mountain Range

The Study area belongs to the eastern part of the Neyba Mountain Range Hydro-geological Region. In the PLANIACAS report, it is estimated that the north-eastern sub-region whose underground current flows in the San Juan Valley toward the San Juan River, has the groundwater potential of ***5 to 20 MCM/year***, while the south eastern sub-region, flowing in the San Juan Valley to the Yaque del Sur River has more potential of ***10 to 60 MCM/year***.

(c) Neyba Valley

The groundwater in the Neyba Valley is considered to be produced by the recharge (infiltration) from the Yaque del Sur River or by those at the flanks of the mountains situated to the north and the south of the Valley, because the geological formation of the Neyba Valley itself is not considered to contain rich aquifers nor water sources for the recharge.

In the PLANIACAS report, it was estimated that the groundwater potential in the hydro-geological sub-region which includes Neyba-Galvan area is about ***100 to 120 MCM/year.***

"Neyba Valley Saline Soil Reclaiming Study" (1988, JICA) estimated the volume of possible groundwater exploitation at 43 MCM/year on the basis of water balance simulation in the Neyba-Galvan alluvial fans. Taking into account the areas of said studies, the groundwater potential to the north end of the Study area in Neyba is considered to be approximately ***50 MCM/year.***

As for the southern part of the Valley near Rincon Lake, the groundwater potential was estimated at about 50 MCM/year by PLANIACAS, which partly runs into Rincon Lake, the Yaque del Sur River and to the sea. However, the possibility of exploitation in this area is considered very limited to the locations along the Yaque del Sur River, and moreover, some risks on the groundwater exploitation, for example, salt intrusion, were pointed out.

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[15] : Plan Nacional de Investigacion Aprovechamient y Control de Agua Subterraneas

(d) Azua Valley

Azua Valley is divided into two hydro-geological sub-regions, namely, VA1 (area covered by the Laterals of the Ysura Canal System) and VA2 (extension area of the Ysura Canal). Getting abundant irrigation water from the Ysura Canal, recharge by the irrigation water was estimated at a high rate of 25 MCM/year, while the total groundwater potential in the area was estimated at *75 MCM/year* (PLANIACAS). However, it was also pointed out that the excessive exploitation of groundwater in the southern part of the area might cause interface, in other words, salt water intrusion to the aquifers. It was also recommended that the exploitation should be limited only for controlling of the artesian flows and poor drainage conditions in the area.

According to the estimates by PLANIACAS, the possible groundwater extraction was estimated at *6 to 8 MCM/year* including some recharges from the irrigation canals. The proximity of wells and the small area of the aquifer limit the possibilities to exploit significant quantities of the stored reserves in the area.

3.9.4 Operation Rules of Sabaneta Dam and Sabana Yegua Dam

(1) Organization for Operation of Dams

Operation of the dams in the Dominican Republic is being undertaken according to the agreement between INDRHI and the Dominican Electric Corporation (CDE)[16].

In the Chapter I of the agreement, it is mentioned that the INDRHI will be the institution which is responsible for the waters regulated in the existing and future dam basins, conserving a criterion of optimum operation and ensuring sufficient quality of water to cover the various uses which may satisfy the needs for purposes of irrigation, supply for domestic and industrial use, and in all cases, the maximum hydroelectric production.

For the following-up of the above concept, two administrative bodies were established. They are; i) the Council on the Control of Dam Basins, as the highest level organization to establish general policy, and ii) the Committee for the Operation of Dam Basins, as a body independent of the other, for the purposes of direct execution of the policies established by the Council of Control.

The Council for the Control of Dam Basins is made up by the Executive Director of the INDRHI and the General Administrator of the CDE, as well as the highest-level executives of each institution.

The Committee for the Operation of the Dam Basins is made up by three (3) members of each one of the institutions signing the agreement, who in turn, designate an Alternative Representative, should it be necessary, who will be invested with all the prerogatives of a

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

titular member; plus one representative of each one of the Board of Irrigators, legally constituted, as observer.

The responsibilities of the Committee for the Operation of Dam Basins are:

- To receive and carry out the executive actions conceived and established by the Council on the Control of Dam Basins,
- To review and to evaluate periodically the operational practices and operational procedures,
- To formulate, under emergency conditions, the decisions on the operation of the dam basins, by means of agreements adopted by unanimity, taking into account emergency procedures for the dams with basins, established by the CDE,
- To hold ordinary meetings, *at least once per month*, and extraordinary meetings in agreement with requests by any of its members, under previously established conditions,
- To submit a copy of its Operational Agreements and its Annual Reports to the Council on the Control of Basins, and
- To refer to the decision of the Council on the Control of Basins, those matters which because of disagreements, may require the interpretation of policies and criteria previously established by that organism.

Seven (7) dams are being operated under the control of the administrative bodies; they are Tavera dam, Valdesia dam, ***Sabana Yegua dam***, ***Sabaneta dam***, Hatillo dam, Rincon dam, and Jiguey dam. In 1996, an extraordinary meeting was held on the Hurricane Hortense in September, while in 1997, one extraordinary meeting was held in December for controlling water use because of low storage level of Sabana Yegua Dam.

(2) Ordinary Operation

So far, no storage curve for normal operation has been confirmed for each dam. The basic understandings of the dam operation are:

- To let the water level nearly the maximum operation level by the beginning of the cropping season (November),
- The irrigation areas of the year is 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.

In advance of the cropping season, INDRHI prepares a report[17] which contains estimation of irrigable areas of the dams under the Committee on the basis of the water balance with probability analysis. The basic strategy of dam operations for the season is agreed based upon the report.

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[17] : "Programacion de Siembra en Funcion de la Disponibilidad Hidrica Demandas de Agua en las Areas de Influencia de las Presas a Nivel Nacional".

(a) Operation at Sabaneta dam

Based on the water-release schedule, the site offices of Sabaneta and Sabana Yegua dams regulates the outlets of the dams. In case of Sabaneta Dam, it has two outlets; one is an outlet through a turbine of hydropower generation, which are specified to be driven in the discharge range from 6 m^3/sec to 11 m^3/sec. The other is only an outlet having a maximum water releasing capacity of 18 m^3/sec. In the actual operation, when required amount of water is less than the minimum required discharge of the turbine, the outlet through the turbine is closed and the required amount of water is released through the other outlet. On the contrary, when the required amount of water is more than the maximum permissible discharge of the turbine, the water more than the permissible flow is released through the other outlet.

(b) Operation at Sabana Yegua Dam

Sabana Yegua Dam has two outlets; one is an outlet through a turbine of hydropower generation, which are specified to be driven in the discharge range from 12 m^3/sec to 22.7 m^3/sec. The other is only an outlet. In the actual operation, when required amount of water to be released is less than the minimum required discharge of the turbine, the outlet through the turbine is closed and the required amount of water is released through the other outlet. On the contrary, when the required amount of water is more than the maximum permissible discharge of the turbine, the water more than the permissible flow is released through the other outlet. As the required amount was actually within the specified range in almost the period since the completion of the dam, the hydropower plant has continuously working except the maintenance period.

The actual water levels of Sabaneta dam and Sabana Yegua dam are shown in Fig. 3.9.2 and Fig. 3.9.3, respectively. It is obvious that the tendency of water level fluctuations are similar for most years, but there are very big discrepancies between the water levels at the same date of the years. It is strongly recommended to prepare the standard storage curve for normal operation for better operations.

(3) Emergency Operation

The operation rule for the emergency period is given in "Instruction of Operation in Emergency[18]," which was prepared in 1994 for the seven (7) national-level dams, by the Emergency Dam Operation Committee[19] (COEE). The rule gives basic operations for the emergency period (high water level or quick rise of water level in the reservoir) to maintain the water level more than one (1) meter below the maximum operation level, and in case that the water level exceeds the level, it is instructed that the same amount of water as inflow should be discharged through the outlets.

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[18] : Instructivo de Operación durante Emergencias.

[19] : Comité de Operación de Embalses en Emergencia.

In 1996, COEE made site inspection visits for each dam, and indicated maximum operation levels through a year. The maximum operation levels of Sabaneta dam and Sabana Yegua dam are given below and illustrated in Fig. 3.9.2 and Fig. 3.9.3.

(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

(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

As mentioned in Section 3.2, the design flood discharge of Sabana Yegua dam is being re-evaluated. The maximum operation level of 386.0 amsl during the Hurricane season was determined tentatively, because the re-designed flood discharge (14,000 m^3/sec, PMF[20]) of which out-flow can not be discharged by the existing spillways.

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 is discussed in Sub-section 3.5.4 on the basis of the actual irrigation conditions, such as area, irrigation efficiency, effective rainfall, infiltration rate, cropping patterns, etc. The irrigation water demands by block are summarized below:

[20] : Original design flood discharge (inflow) is 7,800 m^3/sec of which return period is 1 in 1,000 years.

(a) San Juan Irrigation District 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 Irrigation District 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 (Tabara)	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	13,473	6,133	2,930	4,495	13,558	192.0	131.5	323.4

(c) Lago Enriquillo and Yaque del Sur Irrigation District Blocks

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)	370	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)	2,669	90	105	2,200	2,395	46.9	46.6	93.4
Total	22,248	414	483	16,245	17,142	438.1	435.6	828.2

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

(2) Municipal Water

Municipal water use mainly consists of i) drinking water supply though INAPA system, ii) domestic water use without INAPA system and iii) industrial water. INAPA drinking water supply is further divided into two types namely surface water source and groundwater. Water users without INAPA system depend their water sources on streams, springs and groundwater etc. Meanwhile, there exist various types of industries, in which the major

water users are the agro-processing industries. Some of them rely on the INAPA water and the others depend on their own water sources (mostly tube well).

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. For the rural water users without INAPA system, no reliable information is available, hence it was roughly estimated based on the population in the area out of INAPA system. The estimated water use is considered to be negligible for the present water balance study.

There are no reliable record for actual water taking nor registered water right on industry water use as well. Industry water use is therefore estimated based on the list of the industries in the Study area and their water use standard obtained from the HISARQ S.A (*Hidraulica Sanitaria y Arquitectura*). For the water balance study of the area, following figures are given preliminary.

(Unit MCM/year)

	INAPA drinking water supply		Industry
	Surface water	Groundwater	
Azua area	2	8	2 ?
San Juan area	7	6	0 ?
Lago Enriquillo/Yaque del Sur area	8	7	1 ?
Total	17	21	3 ?

(3) River Maintenance Flow

There exists no clear concept of "river maintenance flow" in the Dominican Republic. In the previous studies, a similar concept was discussed as "ecological flow"[21].

The maintenance flow of the river is considered to play roles as follows:

- minimum and emergency water requirements for human living,
- water for the inhabitants in the river
- discharge for avoiding salt intrusion to the inlands

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, Neyba), and minimum requirements (assumed at 50 liters/persons/day), the emergency requirements in discharge are less than 0.2 m^3/sec.

[21] " Informe de Factibilidad vol.4, Anexo C, Estudios Hidrologicos, INDRHI/SNC, Nov. 1984"

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 and also several times (re-use of waters), ***a 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.

Due to lack of data and information at this stage of the study, following limitations are allowed for the water balance:

- Domestic and industrial water demand is not included (data not completed, but small amount compared with irrigation water demand)
- Simulated years are from 1981 to 1994 (data not completed after 1994)
- The simulation is on monthly basis.
- Missing data and records are compensated by interpolation, correlation, substitution, etc.

The procedures of the simulation are mentioned in the following. The simulation primarily used the actual records, then coefficients and factors are adjusted by comparing the estimated figures and the actual records. It should be noted that the figures in the results contain certain errors of at least 20 %, particularly due to discrepancy between the actual operations and proposed ones (in the operation rules) on water supply.

The flow chart of the simulation is given in Fig. 3.9.4.

(2) Settings and Assumptions by Block

The Study area was divided into four blocks according to the administration boundaries of the Irrigation Districts of INDRHI (Fig. 3.9.1). Settings and assumptions for the simulation are described by block hereinafter.

(a) *San Juan Irrigation District Block*

(i) Hydrological check points

Hydrological check points 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. Actual operation records consisting of i) water level in the reservoir, ii) release from the reservoir, iii) volume of the reserves (derived from the storage curve of the reservoir), and iv) inflow to the reservoir (estimated from said i) to iii)). The study team used the storage curve which was revised in 1992 on the basis of the site investigations (topo-survey) of the reservoir.

Paso de Lima is a hydrological station (rivergauge) located upstream the reservoir. The records are used for compensating the inflow data of the reservoir. *Sabaneta* (D1) and *Guazumal* (D1a) are used for evaluating the runoff at the dam site before and after the construction of the dam. *Hato Viejo* (D11) is used for checking of the return-flow rate of Jose Joaquin Puello system, and the available water to Guanito San Juan system. *El Caheo* (D10) and *Vallejuelo* (D12) are used to evaluate the water availability for Mijo and Vallejuelo systems, respectively. *Sabana Alta* (D2) provides the data for the final checking of the simulated and actual runoff at the end of the block.

(ii) Assumptions and Conditions

The following assumptions were made for the simulation:

- Evaporation loss from the reservoir was assumed at 110 % of the Penman's evapotranspiration which was estimated using the meteorological records of San Juan de la Maguana.
- Infiltration loss of the dam was assumed at 0.02 MCM/year.
- In case the amount of water demands exceeds the available water, the water is divided proportionally to hectareage.
- The capacities of the canals are set according to the designed capacity[22] as follows:

Jose Joaquin Puello	8.0 m^3/sec
San Juan Canal	6.0 m^3/sec
Hato de Padre Canal	4.25 m^3/sec
Mijo Canal	4.0 m^3/sec
Guanito San Juan Canal	3.0 m^3/sec
Vallejuelo Canal	2.8 m^3/sec

- The return flow rates were determined based on the cropping pattern, more for paddy rice areas, and less for upland crop areas:

Jose Joaquin Puello	20 % (13 %)[23]
San Juan Canal	30 %
Hato de Padre Canal	30 %
Mijo Canal	30 %
Guanito San Juan Canal	30 %
Vallejuelo Canal	30 %
Others	30 %

- Runoff from the residual catchments between the intakes were estimated using the rainfall data of San Juan de la Maguana. The residual catchments upstream are as follows:

San Juan and Hato de Padre	128 km^2
Guanito San Juan	280 km^2
Sabana Alta	573 km^2

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[22] Source: "District de Riego de la Republica Dominicana", 1995, INDRHI

[23] The return flow of the Jose Joaquin Puello was estimated at 13 %, because some irrigation water flows down outside the Study area.

- Runoff coefficients (percentage of runoff to rainfall) were estimated by month using hydrological runoff model on the basis of daily rainfall data. The average runoff coefficients are given below:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coefficients (%)	48	27	20	21	26	30	27	24	29	33	38	33

(b) *Azua Irrigation District Block*

(i) Hydrological check points

Sabana Alta is the starting point of the block. The water budget (in-flow and out-flow) of ***Sabana Yegua dam*** plays an important role because the dam is one of the starting points of the block. Actual operation records consisting of i) water level in the reservoir, ii) release from the reservoir, iii) volume of the reserves (derived from the storage curve of the reservoir), and iv) inflow to the reservoir (estimated from said i) to iii)). The study team used the storage curve which was revised in 1993 on the basis of the field investigations (topo-survey) of the reservoir.

Palomino is a hydrological station (rivergauge) located upstream the reservoir. The records are used for compensating the inflow data to the reservoir. ***El Puente*** (D3) is used for evaluating the runoff at the dam site before and after the construction of the dam. ***Los Guiros*** (D6a) provides the data for the final checking of the simulated and actual runoff at the end of the block.

(ii) Assumptions and Conditions

The following assumptions were made for the simulation:

- Evaporation loss from the reservoir was assumed at 110 % of the Penman's evapotranspiration which was estimated using the meteorological records of San Juan de la Maguana.
- Infiltration loss of the dam was assumed at 0.04 MCM/year.
- In case the total of water demands exceeds the available water, 60 % of the river water at Villarpando is diverted to the Ysura Conveyance Canal.
- The capacity of the Ysura Conveyance Canal is set at 24 m^3/sec.
- The return flow rates were set for the area along the Ysura Conveyance Canal and the Yaque del Sur River (A1) because of no return flow from other areas in Azua Irrigation District. The return flow rate is set at 20 %.
- Runoff from the residual catchment between Villarpando and Los Guiros was estimated using the rainfall data of Azua. The residual catchment area at Los Guiros between Villarpando is 165 km^2.
- The runoff coefficients were estimated by month using hydrological runoff model on the basis of daily rainfall data of Azua. The average runoff coefficients are given below:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coefficients (%)	20	22	21.	22	26	27	23	21	28	31	34	42

(c) *Lago Enriquillo and Yaque del Sur Irrigation District Block*

(i) Hydrological check points

Los Guiros is the starting point of the block. The actual records are used primarily and the simulated discharges are used in case that the actual records are missing or not available.

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. It should be noted that no automatic recorders have been operated in this block, and the volume of actual runoff and the simulated runoff do not coincide, because the former, which are converted from the readings of gauges taken only twice a day, can not represent hydrographs.

(ii) Assumptions and Conditions

The following assumptions were made for the simulation:

- In case the total of water demands exceeds the available water at Santana headworks, half the water is distributed to the Santana Canal.
- The capacity of the Santana Canal is set at 25 m^3/sec.
- The return flow rates are set at 20 % for all the systems.
- Runoff from the residual catchments between the intakes were estimated using the rainfall data of Tamayo. The residual catchment upstream the each are as follows:

Conuquito	702 km^2
Palo Alto	49 km^2

- The runoff coefficients were estimated by month using a hydrological runoff model on the basis of daily rainfall data of Tamayo. The average runoff coefficients are given below:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coefficients (%)	36	20	20	18	23	47	22	24	25	28	36	32

- Water extraction to Rincon Lake is not considered at this stage, because operational rules for the Tomate drain or the Cristobal Canal have not been confirmed.
- Neyba area is not considered in the water balance of "without-project condition" because few areas (about 40 ha) have been confirmed as "irrigated area" so far.

(3) Adjustment of the Model

The water balance model contains two determinants for 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 or ridiculous to simulate such artificial

operations by formula or models. In this simulation, the artificial factors, particularly, the said percentages of water distribution, etc., are fixed as "given conditions". Only the coefficients of the hydrological runoff model were adjusted to fit the runoff at the check points. The simulation model has been prepared focusing on representativeness of the *base flow* and the *annual runoff volume*.

Consequently, *the basic runoff simulation model under present condition (WB-1)* has been prepared. The hydrographs of the simulated runoff and the actual runoff at representative check-points are compared in Fig. 3.9.5. It should be noted that the model is still being adjusted using additional data being collected, and will be revised and modified in the course of the further study.

(4) Present Overall Water Balance

(a) Inter-Basin Water Balance for Irrigation

Table 3.9.2 to Table 3.9.4 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 and runoff from the residual catchments are summarized in volume by year (total of monthly volume).

Table 3.9.5 to Table 3.9.7 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 too large planted areas 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 Lago Enriquillo and Yaque del Sur irrigation districts, 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 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.
Neyba-Galvan	50	
Others in the Study area	70	Sierra de Neyba and others
Total	250	

Note: refer to 3.9.3 (2) "Groundwater"

Since data on the volume of groundwater use at present is not available, the possibility of groundwater exploitation at certain points is hard to be estimated at this stage. However, it can be said that the groundwater is primarily to be used for the domestic purpose taking into account the limited overall potential, water quality, high cost of water, etc.

(c) Water Balance

The total volume of the surface runoff is estimated by the runoff simulation model without water use (by putting the irrigation area "0"). The average runoff (1981 - 1994) at Palo Alto is estimated at 1,430 MCM/year if none of the river waters are used. 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 are 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.

(5) Considerations

(a) Operation in José Joaquin Puello System

A diversion rate of 60 % is assumed for the José Joaquin Puello Canal at the Sabaneta headworks in proportion to the irrigation area. However, according to the actual records, the shares of the system in water distribution are as follows:

Year	José Joaquin Puello (%)
1989	61
1990	60
1991	74
1992	62
1993	68
1994	76

Source: actual discharge records, Department of Irrigation District, INDRHI

It is noted that the year of 1991 is a "dry year" of more than 1-in-100 years return period, while 1994 is 1-in-10 years' dry year. It is clearly shown here that "even distribution" is not realized in the present system here mainly because "no real-

time monitoring system" is available on water distribution in the Sabaneta Irrigation System. The determinative factor of the irrigation system is considered to be the canal capacity.

(b) Losses in Ysura Conveyance Canal

Discharge measurements were carried out during the Study period at several points along the Ysura Conveyance Canal in order to clarify the losses along the canal. The results are summarized below:

Point	Jan 15, 98	Feb 698	Remarks
Yaque del Sur (Villarpando)	14.9 m^3/s	11.9 m^3/s	
Ysura Conveyance Canal (YCC) Head	9.0	6.9	60% of river water is taken.
Biafara River (End of YCC)	8.1	5.1	
Ysura Canal Head	6.5	3.5	
Conveyance loss (%)	27.7 %	49.3 %	

Source: Discharges measured with a current meter by staff of South Region Hydrological Office, INDRHI

It should be noted here that conveyance efficiency between Villarpando and the Tabara headworks is considered very low, presumably due to water extraction from the conveyance system and poor conditions of facilities.

Several new irrigation projects are being implemented, of which irrigation waters are to be taken from the Conveyance Canal. It is suggested that due consideration should be paid on allocation of the waters of the Ysura Canal System.

(c) Intake Efficiency of Small Irrigation Systems

There are a number of small irrigation systems along the Yaque del Sur River and its tributaries. In particular, in Barahona area, plenty of pumping systems are being operated. In the results of water balance, those areas have sufficiency rates of nearly 100 % mainly due to their small areas compared with the big runoff volume. However, it should be noted here that the operational efficiency of the pumps is very low due to insufficient power supply.

The type of intake facilities of small gravity irrigation systems along the Yaque del Sur River is mostly "free intake", of which intake discharge depends on the river water level. Thus, the intake efficiency of such systems is also considered very low especially in dry periods.

(d) Determinative Factor of the Runoff

On the down reach, particularly downstream of the Santana headworks, a large part of the runoff of the Yaque del Sur River is composed of the remaining discharge from the upstream, and the return flow. Rainfall being small in the downstream area, runoff from the residual catchments does not contribute a lot to the runoff. Moreover, the return flow from the San Juan area is shared with Azua block, and the return flow from the Azua area does not flow into the Yaque del Sur River. Accordingly, it is

considered quite reasonable to secure certain discharge by period at the end of Azua Irrigation District, namely Los Guiros, and control the diversion to the Ysura Canal at Villarpando.

(e) Re-use within the Area

In San Juan area, some part of irrigation waters are re-used. The irrigation water for the San Juan system is drained to the Jinova River which flows in the east of the area, and the water is re-used on the downstream. Such "re-use within the area" was not considered or assumed in the inter-basin water balance. In the large irrigation systems, such practices are undertaken, and certain re-use rate (20 % to 40 %) can be accounted according to the level of irrigation and drainage network.

(f) Irrigation Area

The water balance was examined on the basis of the actual planted areas of these three to five years. It means that, even the sufficiency rate is 100 %, there is no guarantee to be irrigated in the proposed conditions for a wider area. The water balance under the proposed (with-project) conditions will be examined in the further study.

(g) New Project on the Upper Reach

Several "new" projects are being implemented, of which intakes are located at the upper reach of the existing irrigation systems. Amiama Gomez and Biafara Irrigation System (under construction) is designed to extract water from the Ysura Conveyance Canal at about 3 m^3/sec in total.

"Aguacatico" of which intake is located on the upstream of the Santana headworks, is also an extension project. The design discharge will be increased at one (1) m^3/sec which is to be diverted from the Yaque del Sur River.

These new projects are generally planned on the upstream of the existing and currently-used water source to secure water extraction. Taking into consideration the limited volume of the source in the Study area, it is strongly recommended to coordinate and control the new irrigation development beforehand.

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 Potential and Constraints

(1) Land and Water Resources

Based on the USDA land capability classification system, class-I to class-IV are able to be developed for intensive agriculture. Within the study area, there is a total area of about 175,000 ha of classes II to IV or 24.7 % of the total land area that could be irrigated if water is available. The remaining areas are classified into V to VIII of which most are extended to the very steep and undulated area and are not suitable for irrigation farming.

The main limiting factor to extensive development of the potentially irrigated lands within the study area is the scarcity of water resources. The climate is semi-arid or arid. The average annual rainfall is 500 mm in Neyba valley to 1,500 mm in the upper reaches in the Yaque del Sur river. There is a considerable year to year variation in rainfall. Most of the rainfall is concentrated in several months during the rainy season. These climatic conditions have hindered agricultural development in the study area.

However, the annual average cropping intensity in all the existing irrigation systems is as small as 80 %. Based on the results of the water balance study in the whole Yaque del Sur river basin, the total water demands at present conditions are estimated at about 1,620 MCM/year consisting of the irrigation demands of 1,550 MCM, municipal demands of 40 MCM/year and river maintenance flow of some 30 MCM/year. On the other hand, the total volume of potential sources is estimated at 1,680 MCM/year consisting of 1,430 MCM of surface water and about 250 MCM/year of the groundwater. Needless to say, all the potential water resources cannot be used. The results of the study indicate that the available water resources can be meet only 90 % of the present demand.

(2) Agriculture

Main agricultural products in the study area come from the irrigation systems consisting of about 71,000 ha. In addition, there are agricultural activities on rainfed land (46,000 ha) and shifting culture/natural on pasture land (154,000 ha) where, however, have low agricultural potential due to severe conditions of rainfall and poor land potential. Most of these land develop over the steep land and are denuded because of the extensive cutting of trees and the existence of agricultural practices similar to shifting cultivation. Moreover, cultivation on these lands have brought about severe soil erosions at a rate of 2-4 mm/year and threatened a rapid sedimentation of the dams.

As far as the existing irrigation systems in the study area is concerned, the Santana sugar estate was constructed with one diversion weir and irrigation systems in 1916. Afterward, Sabaneta and Sabana Yegua dams and irrigation systems were constructed under the framework of the national development policy during the 1979-1980. These irrigation developments contributed to the provision of irrigation water in the areas of Azua and San Juan provinces in the study area. Afterward, however, no large investment has been performed and proper maintenance of the irrigation systems has not been carried out. As a

result, a lot of irrigation systems have deteriorated. Development of water users associations to conduct proper irrigation water management has also been delayed, which has accelerated not only deterioration of the irrigation facilities with low irrigation efficiency but also technical problems such as water logging and salinity.

Under such situation, introduction of improved irrigation farming into the study area has been hindered. The unit yields of crops are low: paddy 3 tons/ha, bean: 1.1 tons/ha, plantain:20 tons/ha, banana:29 tons/ha, cassava: 9 tons/ha, pigeon pea:1.5 tons/ha, coffee: 0.25 tons/ha, sugarcane: 30 tons/ha, corn: 2 tons/ha. The main causes of the low crop yield are assumed to be caused by (1) deterioration of seeds, (2) a lot of crop damages due to pests and diseases, (3) low level of farm inputs such as fertilizer, (4) insufficient availability of irrigation water, (5) difficulties of land preparation and (6) others. In addition to low crop yield, the multi-cropping index is very small even in irrigated land, being 80 % a year as mentioned previously. The main causes for the low multi-cropping index are considered to be resulted from (1) low availability of irrigation water, (2) low capability of purchasing proper amount of farm inputs such as fertilizers, seeds, chemicals, etc and (3) shortage of tractors and their attachments for land preparation. As a result, agricultural productions from the study area are limited.

(3) Agricultural Support Services and Social Matters

Agricultural support services are one of the most important factors for farmers to properly increase agricultural production. At present, most of the governmental agricultural support services such as extension, research, seed multiplication and agricultural information are poor because of lack of budgets, insufficient of necessary facilities and equipment for providing services to farmers. About 90 % of budget of the related organizations to agricultural support services is allocated to personnel cost, which means that such functions of the organizations seem to be practically active.

Access to credit services in the study area is poor. The agricultural bank is the main bank to provide credit to agricultural sector. In 1996, the bank provided the sector with 44 million pesos for about 1,100 number of loans consisting of an area of 4,500 ha. Most of those loans are provided through the agrarian reform programs. Most irrigated farmers have poor access to this credit.

With water users associations, only two associations such as YSURA irrigation committee and Sabaneta dam irrigation committee which have about 7,890 members were formed, which indicates about 38 % of the total farmers in all the irrigated areas. At present, water management of the irrigation systems is performed with a great deal of assistance and help from INDRHI even in the said committees. As mentioned previously, operation and maintenance of the systems are not properly functioning and strengthening of water users associations are urgently needed.

Farm size of the farmers in the study area is small. According to INDRHI data, an average farm size of the irrigated farmers in the study area is 2.32 ha. The farm size is different depending on locations. The farmers in San Juan irrigation district have an area of 3.5 ha on average, on the other hand, farm size in Azua, Enriquillo and Yaque del Sur irrigation districts is about 1.7 ha.

As far as development of infrastructure is concerned, the study area is one of the most disadvantaged regions in the county. It was estimated that a greater percentage of the population in the study area do not have access to basic services such as rural electrification (rate on receiving service: 69 %), potable water (38 %), sanitary (28 %) and rubbish disposal system services (68 %). The ratio of local people who receives such social servicing in the study area appears about 10 % lower than that of national level. Further, most of rural roads are not sufficiently maintained periodically due to the lack of financial resources, badly affecting the transportation of the farm products especially in the rainy season.

As a result, incomes of the farmers in the study area become low and their living standard is also low not only on income level but also quality of life. The government census in 1993 identified that the study area is the least developed part of the country. Within the study area, the highest concentration of poverty specially persists in the southwest. Migration is very high in the study area. The poor conditions of the area have created a vicious cycle or `Low development Trap`. People with some high education or qualification migrate in search of better opportunities. Those who remain do not have the capability to undertake development ventures. As a consequence, private investment is missing in the area and the political clout is reduced when the best qualified leave the area.

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 based on six broad objectives as mentioned in chapter 2. The Government sector policy in agriculture has been defined in the following areas:

(i) Agricultural Production: promotion of food production to achieve self-sufficiency on the main stable food and export crops, and enhancement of the level of production and income level in small farmers

(ii) Marketing and Price Policies: promotion of elimination of all tariff and non tariff barrier to agricultural production and trade, promotion of trade liberalization and market access, reduction of price controls for farm input and outputs, promotion of private initiatives for domestic agricultural markets

(iii) Credit Policy: increase credit access the agricultural sector, continuation of credit support to main crops

(iv) Irrigation Policy: increase of investment on irrigation facilities and maintenance of the existing irrigation systems, improvement irrigation system management by extending and increasing water charges and handover of management for irrigation system to water users, improvement of legal and institutional arrangement

(v) Natural Resources Policy: promotion of soil conservation, zoning of appropriate land use, promotion of watershed management through agro-forestry industry by small farmers

(vi) Research and Extension Policy: promotion of coordination between research and

extension systems, promotion of efficient management mechanism of Agricultural Research centers decentralizing their operation and incorporation of the private sector and farmers

(2) Farmers' Desires

In order to identify constraints and desires which the farms in the study area contemplate, JICA study team conducted farmers` interview survey in 1998 from the view points of (1) main constraints related with crop production, (2) main constraints on marketing of agricultural products and (3) desires for agricultural development. The results are shown below:

Constraints	Ranking by farmer
(1) Crop production	
Availability to irrigation water	First
Drought	Second
Access to credit	Third
Pest and diseases	Fourth
Soil fertility	Fifth
Lack of technical assistance	Sixth
(2) Marketing	
High control by local middlemen	First
Fluctuation of farm gate price	Second
Poor road conditions	Third
Lack of market outlet	Fourth
Lack of support services	Fifth
(3) Agricultural development	
Construction of irrigation facilities	First
Access to subsidized credit	Second
Construction of Aqueducts	Third
Access to subsidized inputs	Fourth
Construction of community facilities	Fifth

(3) Basic Development Concept

Main constraints on the integrated rural development in the river basin include poor rural infrastructures, lack of advanced agricultural technology and poor agriculture supporting systems. Meanwhile, the constraints are soil deterioration and erosion due to the shifting cultivation in the hilly area, and the water shortage due to the scarcity of rainfall, deterioration of existing irrigation and drainage facilities and poor water management and maintenance system in the flat area. These constraints cause serious problems such as sedimentation of the dams, salinity problem, loss of water resources, quality deterioration of agricultural products, low income, and so on. It is therefore necessary to deal with these constraints and problems in order to implement agricultural development effectively.

With respect to the rainfed agriculture, (including the shifting cultivation) in the hilly area, reforestation and settlement of the farmers of the shifting agriculture and revitalization of the poor coffee farmers, are promoted in order to conserve the land (soils and water) and to increase and stabilize the cash crops production. This aims at solving the above constraints and problems inherent in or relating to the agriculture and replying the national

development policy and farmer' intention for the purpose to stabilize the small farmers and improvement of the living standard. For the irrigated area in the flat land, in order to improve the present low irrigation efficiency and to use water effectively, overall water management, rehabilitation of existing irrigation, drainage facilities and establishment of the water user' organization are promoted to increase and stabilize the production of the food crops and the cash crops.

In order to support the sustainable agriculture, measures should be taken including introduction and establishment of multiplication, distribution of the improved seeds/seedlings, improvement of the development and the delivery system of the practical farming technology. It also includes, organizing cooperatives including collection and distribution system, strengthening of the agricultural market information system and the setting up of the credit services.

In order to achieve this purpose, development plans are formulated on seven sectors of (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

In spite that irrigation have been provided for an important part of the Study area, still there are many factors that are hindering the achievement of maximum potential for agricultural production. The agricultural development plan for Yaque del Sur river basin is set with the main objectives of increasing total agricultural production through improvement of average yield of crops and cropping intensity in the Study area. In order to achieve this objective it is necessary to implement projects and programs for introducing appropriate farming practices, including the use of improved crop varieties, good quality seeds, and adequate level of fertilization.

4.2.2 Land Use Plan

(1) Land Use Pattern

The future land use pattern in the Study area should be based taking into consideration factors such as land capability, soil erosion problem, and water availability either from rainfall or irrigation. On the basis of USDA land classification system, the land area that could be developed for intensive agriculture are those classified in classes I to IV. In the Study area there are about 175,000 ha classified between class II and IV, which is equivalent to 24.7 % of the total area, and the other 75 % of land in the Study area is classified between classes V to VIII. In relation to climate, about 351,200 ha, equivalent to 49.5 % of total Study area are classified as semi-arid lands, and about 50.5 % of the Study area is classified as humid and very humid lands. Almost all the land of humid and very humid climate is classified in classes V to VIII of USDA classification system; most of that land is of steep slopes. The recommended use for those lands classes are limited to well managed range grassland, woodland, and agro-forestry, including fruit trees, and coffee.

There is an area of about 154,000 ha that at present are being used inadequately for shifting cultivation and natural pasture; the poor management of land used for shifting cultivation is causing serious erosion problems in the Study area. There are about 26,000 families engaged in shifting cultivation. To promote adequate use of steep slope lands, the present Master Plan proposes the conversion of shifting cultivation land of 154,000 ha to sustainable permanent type of land use. The land use will be changed into 52,000 ha (2 ha per family) for hilly land agriculture of annual and perennial crops with introduction of land conservation measures; and the remaining area of about 102,000 ha will be converted to forest land.

Almost all the land classified between classes II to IV are located in the semi-arid zone, therefore the possibility for agriculture development depends on the availability of irrigation water. At present the existing irrigated agricultural land comprises about 71,000 ha. Because limitation of water resources, 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. An exception is made for a land area of about 6,540 ha in total that includes the proposed Galvan groundwater development projects of about 540 ha, and the on-going INDRHI's projects covering about 5,950 ha for new land developments, including (1) PRODAS (about 3,000 ha), (2) Amiama Gomez-Biafara area (about 2,160 ha) and (3) Aguacatico irrigation project (about 750 ha). The water balance study made by JICA Study team indicates that there is water shortage to satisfy present demand, considering present irrigation efficiency.

On the basis of the above considerations, the proposed land use by the Master Plan is indicated below.

Land Use	Present		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, Except shifting cultivation	46,000		98,000	
Shifting cultivation and Natural Pasture	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	19.0	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 Crops and Cash Crops Production Improvement Plan

(1) Irrigated Agriculture Production Improvement Plan

(i) General

One of the main causes of low cropping intensity is the sacristy of water resources in the Study area. The improvement of irrigation efficiency as result of implementation of proposed projects will increase availability of irrigation water. It is proposed that future additional available water be used to achieve an increase in the cropping intensity in existing irrigated lands, and limit the increase the irrigated lands.

(ii) Selection of Crops

The proposed crops are those 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. As mentioned above, major crops are plantain, banana, and tomato for processing in Azua; rice, red bean and pigeon pea in San Juan; and plantain, banana and sugarcane in Yaque del Sur and Lago-Enriquillo irrigation districts.

(iii) Proposed Cropping Patterns

The formulation of proposed cropping pattern is made giving special emphasis to the following points:

(a) 120 days improved variety of paddy with growing period of 120 days is introduced instead of 150 days day-growing period variety in order to minimize the irrigation water requirement.
(b) 80 days Improved variety of pigeon pea the growing period of 80 days is also introduced instead of present 270 days day-growing period variety in order to minimize the irrigation water requirement and to effectively utilize the rainfall.
(c) Planting period of industrial tomato is fixed during cool season from October through March in order to minimize the damages due to pests and diseases.
(d) Planting period of red bean is also fixed during cool season from the beginning of November through March in order to minimize damages due to pests and diseases.
(e) Repeating continuous cultivation of tomato for processing is prohibited in order to prevent crop damages due to the repeating.

The criteria for deciding the cropping pattern and area to be planted of each crop in the different irrigation systems are set taking in consideration: (1) availability of irrigation water; (2) present cropping pattern; (3) present percentage of area planted by crops; (4) government's agricultural policies and regulations for crop production in the region and for national food security, as follows:

(a) The maximum cropping intensity to be achieved at each irrigation system

depends on the availability of irrigation water. The area that can be planted to different crops in each irrigation system With Project condition is decided on the base of water balance analysis as indicated in irrigation development section.

(b) As a government policy for the region, the area planted to rice should not be increased within the study area.

(c) The area planted to sugar cane in Yaque del Sur - Lago Enriquillo irrigation districts will be reduced to an area sufficient to satisfy the present milling capacity of the Barahona Sugar Mill. The area released from sugar cane will be planted to crops that have proven well in the area.

(d) The area to be planted of each crop With Project condition is decided following a cropping pattern same as the present condition, and augmenting the area of each existing crop proportionally to the percentage of area occupied at present by each crop, except for banana. According to the estimates made by the Ministry of Agriculture, the area planted at present to banana is larger than the area required to ensure national food security up to the year 2005, therefore the area planted to banana is not increased With Project condition.

(iv) Proposed Farming Practices

To attain the target yield of crops under irrigation condition, it is necessary to introduce significant improvement of the farming practices, including selection of varieties, use of good quality seeds, adequate level of fertilization, adequate on-farm water management, effective control of pest and diseases, etc. The recommended farming practices for irrigated agriculture production are described in Table 4.2.1.

(v) Anticipated Yields and Crop Production

The target yield of each crop planted in the Study area under irrigation condition is set based on the review of available local data, discussion with research and field workers, or international publications related to Tropical agriculture, as indicated in Table 4.2.1. The anticipated yields of major crops on irrigated land with project condition are summarized below.

Unit: ton/ha

Crop	Yield Present/Without Project	Yield With Project
Rice	3.0	4.5
Bean	1.1	1.5
Plantain	18	23
Industrial Tomato	25	30
Banana	26	36
Sweet Potato	13	17
Cassava	9	12
Pigeon pea	1.5	3.0
Sugar cane	30	130
Corn	2.0	2.8
Sorghum	3.5	4.5

The agricultural development plan aims to introduce adequate farming practices in

order to achieve increase of yield as indicated in the table above, and the improvement of irrigation efficiency will allow significant increase in cropping intensity. The anticipated total production of major crops in irrigated land after the full implementation of proposed projects is summarized below (Ref. Table 4.2.2).

Unit: ton

	Azua Zone		San Juan		Yaque del Sur		Lago Enriquillo	
Crop	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project
Plantain	72,800	115,300	3,800	8,900	101,800	166,000	12,600	78,200
Banana	20,500	28,500	4,200	5,900	36,800	51,000	500	700
Rice	970	1,460	23,900	35,900	100	150	130	200
Bean	1,300	2,300	10,800	22,600	70	120	220	1,700
Ind. Tomato	79,200	112,000			1,500	2,300	2,300	31,400
Pigeon Pea	1,900	2,600	6,400	7,300	25	70	1,200	1,300
Corn	1,900	3,400	2,900	7,200	100	200	700	4,400
Sorghum	3,000	4,800	2,600	8,000	150	200	200	6,000
Sweet Potato	3,500	5,000	27,600	76,900	250	400	4,800	5,200
Cassava	4,700	7,900	6,000	8,200			4,000	48,000
Sugar Cane					34,200	87,400	230,000	373,000

(2) Rainfed Agriculture Production Improvement Plan

(i) General

Most of the land devoted to rainfed agriculture production in the Study area is classified in classes not suitable for intensive farming, mainly due to steep slopes, stoniness, etc; The rainfall pattern on those areas varies considerably, depending on the altitude of the land. Most of the areas devoted to rainfed agriculture production is located at altitude from 600 m and above; this is because almost all the land in the Study area that is situated below 600 m has semi-arid climate, and the rainfall can not satisfy water requirement for most crops.

There are two systems of rainfed agriculture production in the Study area, namely sedentary type of production where farmers continuously plant in the same plot of land; and shifting cultivation, where farmers change the plot of land used for crop production; the shifting cycle in the Study area is 3 years. The two main problems affecting rainfed agriculture production in the Study area are low productivity and severe soil erosion.

The main objectives of rainfed agriculture improvement plan are: (1) to promote the change from shifting cultivation to sedentary farming, and therefore reduce land degradation caused by soil erosion; (2) to stabilize and increase agricultural production; and (3) to improve living condition of families engaged in rainfed agriculture. The achievement of these objectives will be pursued by introducing simple and low-cost farming practices that have proven effective in hilly land rainfed farming elsewhere, including selection of best cropping season, selection of crops and varieties, planting density, improvement of soil

fertility by biological nitrogen fixation and use of organic compost, use of contour farming, and introduction of lived soil protection measures.

It is estimated that one family engaged in shifting cultivation use an average area of 2 ha for crop production and the shifting period is 3 years; The improvement plan aims to stabilize agriculture production in one plot of 2 ha by family and transform the rest of the land used for shifting cultivation into forest land. In the Study area there are about 26,000 families engaged in shifting cultivation agriculture.

(ii) Crop Selection

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 mainly as a cash crop for marketing, while other crops are mainly for farm household self-consumption. Taking in consideration that in the Study area annual crops can be grown only once a year under rainfed condition, during the short rainy season, it is proposed to introduce production of perennial fruit tree crops in a portion of the land of farmer; this will help to increase and stabilize farmers' income. The proposed types of fruit trees are orange, mango, avocado, coffee, cocoa, and papaya. The 2 ha farm plot would be divided into 1 ha for production of pigeon pea, 0.25 ha for a mixture of bean, sweet potato, corn, and banana for family consumption, and 0.75 ha for fruit tree planting.

(iii) Planting Season

As mentioned above, in most parts of the Study area the rainfall period concentrate during a relatively short rainy season, and therefore only one cropping season might be obtain under rainfall condition. Base on the rainfall distribution pattern, the recommended planting seasons for annual crops are: (1) in San Juan province the planting season for rainfed agriculture production of annual crops should start at the beginning of August and last for about one month; (2) in Azua and Bahoruco provinces the start of planting season should be at the beginning of September and last for about 20 days. Perennial crops such as banana, plantain and papaya can be planted only in areas of average annual rainfall of more than 1200mm/year.

(iv) Proposed Farming Practices and Anticipated Yield of Crops

The major component of plan for improving rainfed agriculture is to improve farming practices, including establishment of sedentary agriculture production system, selection of varieties, use of good quality seeds, adequate planting season, adequate planting density, soil fertility improvement, and measures for soil conservation. The farming practices are proposed taking in consideration: (1) the levels of present farming practices and knowledge of local farmers; (2) the poor land resources in areas devoted to rainfed agriculture; (3) dependence on rainfall to satisfy crop water demand; and (4) difficult accessibility to the farming lands, which make difficult to transport farming inputs and reach by extension workers.

Use of New Varieties

The crop to be planted in larger areas as cash crop is pigeon pea; the variety planted under present condition is semi-tall and flowering occurs only in season of short-duration days (November-January) and has a growing period between 90 day up to 270 days, depending on planting date. The recommended pigeon pea variety is "Indian" which is dwarf and has a growing period of 80 days; the introduction of this variety in rainfed areas would make possible to attain good yield if planting at proper season. The second most extensively planted crop is red bean; the recommended variety of red bean is "Checa". Other crops, such as corn, plantain, banana, and sweet potato are planted in very small areas, mainly for farmers' household self-consumption.

Planting Method

Similarly to present condition, all farming activities for rainfed agriculture will be done manually, including land preparation, seeding, and weeding by using hoes and machete. The planting density is an important factor of farming practice in rainfed agriculture because competition among plants for soil moisture and nutrients. There is not specific recommendation on planting density for crops under rainfed agriculture in the Project area. Suitable planting densities is one item subject for testing activities of the improvement plan. Contour planting and ally crops (grass and trees) systems will be promoted as a ways to reduce soil erosion.

Soil Fertility Improvement

Data on soil fertility of hilly lands is not available, but it is assumed that those lands used for rainfed agriculture in the Study area have low soil fertility, mainly due to continuos soil erosion; the improvement of soil fertility is an important component of the plan for rainfed agriculture. Chemical fertilizers will be used only in small amounts during the first two years of implementation of improvement plan; the recommended amount of plant nutrients by crops is indicated below. The long-term improvement of soil fertility will be based on the introduction of farming practices such as use of nitrogen-fixing bacteria mixed to seeds of pigeon pea and red bean, use of compost, recycling of crop residue, and reduction of soil erosion.

The expected yield of crops under improved rainfed agricultural farming is summarized as follows:

Crop	Variety	Fertilizer Application (ton/ha)	Yield (ton/ha)
Pigeon Pea	Indian	N= 10; P=15; K=15	1.3
Red Bean	Checa	N= 15; P=18; K=18	0.5
Corn	Frances Largo	N= 25; P=20; K=15	1.0
Sweet potato	Amarilla	N= 20; P=20; K=20	8.0
Banana	Media Mata	N= 65; P=30; K=30	16.0
Plantain	Macho por Hembra	N= 65; P=30; K=30	14.0
Orange	Valenciana	N= 55; P=70; K=50	8.0
Avocado	Semil and Choquette	N= 50; P=50; K=50	6.0
Mango	Banilejo and Juan Jaquez	N= 50; P=50; K=50	9.0
Papaya	Solo I	N= 75; P=50; K=50	20.0

The areas to be planted by crops and the estimated total production of each crop is indicated as follows:

Crop	Planted Area (ha)	Yield (ton/ha)	Production (ton)
Pigeon Pea	43,000	1.3	55,900
Red Bean	4,300	0.5	2,150
Corn	2,000	1.0	2,000
Sweet potato	2,150	8.0	17,200
Banana	1,100	16.0	17,600
Plantain	1,200	14.0	16,800
Orange	10,750	8.0	86,000
Avocado	8,600	6.0	51,600
Mango	8,600	9.0	77,400
Papaya	4,300	20.0	20.0
TOTAL	86,000		

The total requirement of inputs including seeds, seedlings, fertilizers are listed in Table 4.2.3

(v) Plan Implementation Works

The area target for rainfed agriculture improvement plan comprises the land of about 34,000 ha that at present is being used for sedentary rainfed agriculture production and the 52,000 ha proposed to be change from shifting cultivation to sedentary cultivation; this make a total area for the plan of 86,000 ha.

The plan for improvement of rainfed agriculture production include:

(1) Implement necessary additional studies for detailed proposed land use plan.
(2) Introduction of appropriate farming practices
(3) Installation of eight demonstration plots for sustainable hilly land farming system, one for each larger community (Padre las Casas, Guayabal, Bohechio, Gajo de Monte, El Recodo, Arroyo caño, Sabana Grande, Batista); The size of each demonstration plot will be 0.2 ha. Demonstration will be done during two cropping seasons for annual crops and during 5 years for fruit trees.
(4) Supply the initial seeds of recommended varieties of pigeon pea and red bean to beneficiary farmers for the first year of the plan.
(5) Installation of 25 community nurseries of about 1 ha each for production seedling required for fruit tree plantation.
(6) Strengthening the extension services, including training to extension workers and preparation of extension kits on subjects of recommended sustainable hilly land farming

The target land areas for improvement of rainfed agriculture development plan will be completed in a period of 5 years for the annual crops areas and 10 years for the fruit tree planting areas. The estimated costs of the program are summarized as follows:

Unit: 000 DR $

Item	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Demonstration Farms	125	125								
Community Nurseries	325	325	325	325	325	325	325	325	325	325
Seeds Supply	7,350	7,350	7,350	7,350	7,350					
Extension Service	356	356	250	250	250					
Total	8,156	8,156	7,925	7,925	7,925	325	325	325	325	325

4.2.4 Coffee Production Improvement Project

(1) General

In the Study area there are about 12,000 ha of land planted to coffee. It is estimated that about 60 per cent of the coffee area is very old and in deteriorated condition. Majority of coffee plantations belongs to small holders, with average of 2 ha per household; there are few large coffee farmers within the study area. Husbandry of coffee plantation of small farmers is inadequate due to lack of economic resource and inefficient agricultural extension service. The coffee variety planted in small coffee farms is Typica, which is of relative low yielding. The Caturra variety produce higher yielding than Typica variety, but still only a small per cent of coffee farmers in the study area have planted Caturra variety. Average yield of coffee is 0.25 ton/ha, but few large coffee farmers within the study area are getting yield as high as 2.2 ton/ha.

The main problems affecting coffee production may be summarized as follows: (1) Low yield because the plantations are very old and variety is of low yield; (2) Lack of seedlings of high yielding variety; (3) Inadequate farming practices, including low amount of fertilizers and no control of insects and diseases; (4) Insufficient technical assistance; (5) Lack of infrastructure for post-harvest management of coffee, the existing infrastructure belong to large scale farmers and middleman and are located far from the production areas; (6) intervention of middleman; and (7) weak organization of small farmers.

Majorities of coffee plantations are located in Azua province, including the municipal districts of Padre las Casas, Guayabal, within Las Cuevas river sub-basin, and Peralta municipal district. Other important coffee areas are located in Bahoruco province, including the municipal district of Neyba and Galvan (Ref. Tab. 4.2.1).

The Coffee Production Improvement Project aims to increase coffee productivity in small and medium size farms, farmers with a maximum of 10 ha per household. To achieve this objective a gradual replanting of old and low yielding coffee plantations will be implemented, and the adoption of adequate coffee husbandry will be introduced, emphasizing introduction of soil conservation measures, adequate fertilization, and implementation of Integrated Pest Management for insects and diseases control. The project beneficiaries will be small and medium size coffee farmers with land located at elevation above 600 m. The total target project area is 7,200 ha of old coffee plantations, and the estimated number of direct beneficiaries is about 3,500 households of coffee farmers. Due to economic limitations of small coffee farmers, it is necessary to establish an agricultural credit line specially defined for the implementation of the project in order to make possible the replanting of old coffee plantations and the installation of needed infrastructure for adequate post-harvest management of coffee grains.

Another objectives of the project are to increase farmers' net benefit and improve the living conditions in the coffee producing communities within the project areas. These objectives will be achieved by: (1) improving post-harvest management and quality of coffee

to attain higher selling prices; (2) promote and/or strengthen the association of small and medium scale coffee farmers for them to take advantage of economy of scale by buying inputs and selling production as group; (3) processing and marketing of coffee by local coffee grower associations; (4) provision of some needed services such as agricultural credit and effective technical assistance; and (5) improvement of rural roads to facilitate transport of coffee.

(2) Improvement Plan

(a) Farming Practices

To achieve the target increase in yield of coffee, in addition to the replanting of old, low yielding coffee plantations, it is necessary to ensure the implementation of adequate coffee farming practices in the project areas. The extension service will be strengthened to be able to guide coffee farmers on the implementation of adequate farming practices.

(i) Recommended variety

The recommended coffee variety is Caturra, which is of high yielding and easy to harvest the coffee beans because of the shape of the trees.

(ii) Planting Method

Planting distance will be 2.5 m by 2.5 m, resulting in 1,600 plants per hectare. The planting holes should have a minimum dimension of 0.3 m in all directions. The hole should be filled with top soil from its nearby, mixed with mulching material locally produced.

(iii) Shading

Shading of coffee plantation is considered necessary in the project areas to help regulate variations of air temperature and soil moisture, but attention should be given to avoid excessive competition of shade tress with coffee trees. The project areas are already covered by shading trees, and there is the need to introduce an adequate management, including thinning and/or pruning of existing shade trees, before planting the new coffee tress. In addition to reduce competition with coffee, an adequate management of permanent shade tress may permit to increase the production of some food crops during the three first years after replanting the old coffee plantations in the project areas.

(iv) Fertilization

As a general guideline the amount of plant nutrients recommended are as indicated in the table below. Soil analysis will be carry out during project implementation to determine the specific fertilization recommendations for different land management units within the project areas.

Unit: kg/ha

Nutrient	YEAR							
	1st	2nd	3rd	4th	5th	6th	7th	8th
N	45	50	50	80	100	150	175	195
P	15	15	15	60	80	100	115	120
K	15	15	15	20	30	40	45	60

(v) Inter-cropping

At present, almost all small and medium coffee farmers in the project areas have a mixture of crops interplant with coffee, the most common inter-crop is banana. The present management condition of inter-cropping in the project areas is not adequate, and high competition between coffee and shading trees for light, nutrients, and water seems to be one important cause of the low yield obtained at present. In the future with project implementation, the extension service should introduce the adequate management of inter-cropping. Inter-cropping with annual crops that help improve soil fertility such as pigeon pea and beans can be undertaken during the first three years after replanting of coffee plantations by the Project. After the third year from replanting, inter-cropping should be avoid or reduced to a minimum level that does not cause competition between coffee and inter-cropping.

(b) Seedling Production Program

One important present limitation for improving coffee productivity is due to the scarcity of seedlings of good variety. In the project areas there are only few small coffee nurseries managed by the Ministry of Agriculture, which normally supply free seedlings to small farmers.

To ensure availability of seedlings required for replanting the 7,200 ha of coffee, the project will establish nurseries for multiplication of seedlings of Caturra variety. Each association of small coffee farmers will develop and managed their own nursery. The associations will receive technical guidance from the extension workers of Ministry of Agriculture on how to manage their coffee nurseries. The association will sell the seedlings to its farmers members at an adequate price to cover the full cost of seedlings production. A detailed annual seedling production plan will be prepared in coordination between leaders of farmers associations and the extension workers.

The nursery site should be carefully chosen considering accessibility, water availability, a land area that has gentle slope and is protected from flooding and strong winds. As a general rule the nursery area should be about 1 percent of the area to be planted of coffee each year. One association of 20 farmers has in average 40 ha in total and will replant in 3 years; therefore it is estimated that in average the size of one nursery for of each association will be about 1,300 m^2. The cost of nursery development will be included in the loan to be provided to the small coffee farmers association.

The development of nursery will include (1) land leveling; (2) construction of shading; (3) installation of water faucets for watering the seedlings using hose; (4) construction of drainage system around the upper slope side of the area to control damage to seedlings by flush flooding.

Seedlings will be grown in polyethylene black bags with open holes. The coffee department of Ministry of Agriculture will provide high quality seeds of Caturra variety carefully selected elsewhere in the country from healthy and high yielding trees. Seeds should be pre-germinated by soaking in water for 24 hours before sowing them directly in the polyethylene bags.

(c) Improvement of Post-harvest Management and Quality of Marketable Coffee

After harvesting the coffee cherries, it is necessary to remove the beans from the cherries, to clean and dry them to finally obtain the marketable coffee grains. There are two different ways of transforming the coffee cherries to marketable coffee, namely the "Wet" method and the "Dry" method. The wet method of post-harvest management of coffee is the one generally used in the Dominican Republic. The wet method is recommended for attaining high commercial quality of mild coffee. Special care is needed during the entire process of post-harvest management of coffee to attaining a clean, high quality grain with less than 12 per cent moisture content ready for storage or marketing. If the coffee cherries are not properly managed, some undesirable fermentation may occur and reduce its quality.

Present conditions of post-harvest management of coffee are not conducive to attaining high quality grains. Majority of small coffee farmers makes the pulping of coffee cherries individually at small scale and with inadequate infrastructure. After pulping the cherries, small coffee farmers usually sell the wet beans to middlemen, therefore the farmer get a low margin of benefit in the marketing of their coffee.

To increase the margin of benefit obtained by small farmers, the project will introduce a system of post-harvest management and marketing the coffee by association of farmers as follows: (1) The association of 20 neighboring coffee farmers will have one common facility adequately located and equipped to carry out the pulping of coffee produced by its members; (2) The association of small coffee farmers will have and manage by themselves the infrastructure necessary for sun drying, hulling, cleaning, grading, and storing the coffee produced by its members. All the costs for infrastructure development and acquisition of equipment will be covered through the loan program to the coffee farmers associations. The estimate of infrastructure and equipment number and size required at each level of the association is described in Table 4.2.3.

The associations of small coffee farmers will market the coffee produced by its members through the Provincial Federation of coffee producers.

(d) Improvement of Access Roads

The existing rural road in the coffee project areas will be upgraded in order to facilitate the transport of coffee to the market place. The specific roads to be improved by the project are summarized below.

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

(e) Project Works

The project will be implemented in two phases; During the first phase the works will consist on: (1) detailed planning of the project, including Feasibility Study; (2) organization and/or strengthening of small coffee farmers associations; One association will be formed by 20 neighboring coffee farmers, and there will be a total of about 180 associations in the project areas; (3) development of two Pilot areas of about 40 ha each; (4) training of 5 coffee specialists and 15 extension workers; and (5) approval of loan to the farmers associations for full project implementation.

The work during the second phase of the project will consist on: (1) development and planting of coffee nurseries; (2) replanting of 7,120 ha of old coffee plantations; (3) Improvement of existing rural roads; (4) construction of one drying floors and one small storage buildings for each association of coffee growers in the project area; (5) procurement of equipment for pulping cherry coffee, cleaning and weighing the dry coffee beans.

(f) Pilot Project Scheme

Two areas of about 40 ha each, one for Azua province and one for Bahoruco province, will be developed as Pilot Scheme. The objective of the Pilot areas is to help gain the experience and strength necessary for the full project implementation. The implementation of the Pilot scheme is considered necessary because: (1) At

present there is not enough trained extension workers with sufficient experience for the implementation of the project; (2) It is necessary to do some research to determine specific fertilization needs for coffee in the project area; (3) The coffee farmers should learn the adequate farming practices before replanting their coffee farms; These three conditions will be dealt with during the Pilot Project phase.

(3) Organization and Management

(a) Organization and Management

The first phase of the project, including detailed planing, organization of associations of small coffee growers, and training of specialists and extension workers will be managed by the Ministry of Agriculture. Within this Ministry, the coffee department will be directly in charge of implementation of the first phase. The ministry of Agriculture will hire private consultant to conduct the detailed planning and organization of the farmers associations.

The Ministry of Agriculture will coordinate the provision of loan from the agricultural bank to the viable farmers associations for implementation of second project phase. The implementation of second phase of the project, including development of nurseries, replanting of old coffee plantations, construction of drying floors, etc, will be managed by the association of coffee farmers, which will receive technical assistance from the Ministry of Agriculture and local NGO's.

(b) Training Program

There is a need to implement a training program during the first phase of project for training municipal coffee specialists, extension workers, and farmers' leaders. The training subjects will include adequate husbandry of coffee plantation, adequate post-harvest management of coffee beans, operational management of loans, etc. Five extension workers, one for each agricultural sub-zone of Peralta, Padre las Casas, Galvan, and Neyba, will be trained to become the coffee specialist for their respective agricultural sub-zone. International training in a well-known coffee producing country is necessary for those extension workers to become coffee specialist. The coffee specialist will work in direct coordination and make in the job training to the extension worker of each coffee producing areas. There will be 15 extension workers. The third category of trainees will be the farmers' leaders that will receive training from the area extension workers and by visiting other progressive coffee production areas elsewhere in the country. The trained farmers' leaders will pass their acquired knowledge on coffee husbandry to the members of their respective associations.

(4) Cost

The total estimated costs for the Coffee Production Improvement Project are summarized below (Ref. Table 4.2.3).

ITEMS	Cost DR $, 000
I. Formation and/or Strengthening of 180 Association of Small Coffee Farmers	11,355.2
II. Training to 4 Coffee Specialists, 15 Extension workers, and 180 Farmers' Leaders (Including the construction and Equipment of 2 Training Centers)	11,963.8
III. Procurement of 15 Motorbikes for the Transportation of Extension workers	675.0
IV. Development of 2 Pilot Project Areas belonging to selected Associations (80 ha total)	3,836.0
V. Development of Seedling Areas and Post-harvesting Facilities for 178 Associations of Small Coffee Farmers	206,448.0
VI Improvement of Rural Road for Project Areas	15,492.0
TOTAL	249,770.0

4.3 Plan for Strengthening Agricultural Support System

4.3.1 Plan for Credit Services

(1) General

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

Commercial banks in the study area are deposit takers but are hesitant to lend to agriculture. It has been estimated that commercial banks do not have the institutional capacity to reach small farmers and manage risk in agricultural lending.

The Agricultural Bank (BAGRICOLA) has as its main role to provide credit facilities for the promotion and diversification of the agricultural production and, mobilize saving through saving accounts in order to increase agricultural production. It has been estimated that the Agricultural Bank provides around 30% of the credit for agricultural production in the country. In 1996 BAGRICOLA disbursed RD$1,200 millions to finance different agricultural activities, mainly rice, red beans, garlic, plantain and coffee.

During 1996 the Agricultural Bank offered a low percentage of loans for agricultural production in the study area. In 1996 more than half of the credit loans was allocated among the land reform beneficiaries. The interest charged is currently 18% and the recovery rate for those loans is 80 percent.

The Special Fund for Rural Development (FEDA) is a government institution in charge of special programs and projects aimed at fostering rural development specially in poor areas of the country. Those programs specialize in the production and distribution of goats, chickens and cows among poor peasants, financing small rural infrastructure and supporting appropriate technology projects at the national level. Additionally, FEDA has channeled funds from the International Fund for Agricultural Development (IFAD) for credit, construction of rural infrastructure and research activities. For the fiscal year 1998 the government allocated RD$47.7 millions to support FEDA activities.

There is a lack of formal credit facility to finance non-farm activities in the rural areas of the study area. Some of the NGOs that operate in the area are very limited on the coverage and the funding available for investment in the rural areas. Some of institutions engaged in lending for rural development in the study area includes the Fundacion para el Desarrollo Agropecuario (Foundation for Rural Development, FDD); Fundacion Salud Y Bienestar (Health and Welfare Foundation, FUSABI); Catholic Relief Service-CARITAS; World Vision-FIME; Fundacion para el Desarrollo del Sur (Foundation for the Development of South Region, FUNDASUR) and Fundacion para el Desarrollo de la Juventud Rural (Rural Youth Development Foundation, FUNDEJUR)

Increased agricultural production, poverty reduction, food security and sustainable management of natural resources in the study area cannot be achieved without improving the productivity and profitability of small-scale poor farmers. To do this, it would require innovative approaches that combine resources from the public sector, the private sector, the NGO's, and cooperatives in a strategy that simultaneously addresses the critical issues expressed above.

There is the need to identify and strengthen rural financial institutions that both generate savings and provide funds to farmers and rural residents of the study area. Studies in other countries indicate that households that received micro credits achieved better living standards, higher human development status and greater assets than those who did not have access to them.

Often time investment in agricultural production is not the farmer's priority enterprise, but rather non farm investments that are expected to yield additional sources of income. In addition, rural enterprises among non-farm rural households also have a demand for formal credits.

Specialized rural finance institutions such as the Agricultural Bank (BAGRICOLA) have the mandate by government to serve the rural sector. Although in the past FEDA was heavily involved in development activities in the study area, currently its participation is not significant. Currently the institution is in the process of redefining and strengthening its role regarding rural development in light of the new wave of the country deregulation and trade liberalization.

Likewise, many NGO's have become interested in credit programs but often lack the funds to get started or the broaden their coverage. There is the need to make use of the advantage of NGOs delivering credit because they focus on the very poor, their proximity to the communities and have the capacity to reach the rural poor in remote areas. Additionally the NGOs have the capacity to promote local participation and usually operate at low cost. However, NGOs in the study area have limited technical capacity and lack of broad programming. In this sense there is the need to strengthen their capacity.

On the basis of on the above situation, it is suggested that 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. The first line of credit is aimed at commercial farming and non-farm activities which will strengthen the economic system in the study area. The second line of credit is oriented to provide credit to small holders and poor residents who do not have collateral and can not get access to the formal credit system.

(2) Rural Development Fund

(a) Proposed Activities

This credit line from the pilot project would be used to overcome imperfections in the rural credit market by opening market access to groups and individuals previously excluded due to remote location, inadequate collateral and limited resources of formal financial institution such as commercial banks and the Agricultural Bank (BAGRICOLA).

This general line of credit would be used to make short, medium and long term credit available through competing local financial intermediaries to finance household and enterprise investments in agricultural and other viable rural operations. It can also be used to finance forest enterprises in the upper part of the river basin. Those intermediaries would be the water user associations, farmers' associations and Non Government Organization working in the study area.

In addition to loan for agricultural production, this line of credit could be used to finance other investments such as installation of agro processing facilities, acquisition of agricultural machinery such as tractor, storage facilities, or to provide funding to associations to market their product.

This line of credit would be used to provide group loans to coffee growers and provide operating capital for seed and seedling production by CIAZA. Small farmers, specially those producing plantain and banana in the study area, could also finance their production activities through this credit program

This pilot project would provide start-up funds and technical assistance that include strengthening the local institutions involved in lending.

(b) Organization and Management

This line of credit would be channeled and managed by the Agricultural Bank. The Agricultural Bank would provide credit to Water User Association, Farmer Associations or NGOs at a discount rate as it is shown in Figure 4.3.1. The local financial intermediaries would in turn channel loans to the final users charging and additional percentage. The interest rate charged to the final user would range between 12-14%.

It is expected that the average cost of allocating credit would be minimized by screening loan applicants on the basis or their character and reputation. The local financial intermediaries (water user associations, farmer associations and NGOs)

would charge some percentage to the final borrowers to cover the administration cost, bad debt and even create some funding to strengthen the program.

Technical assistance and training would be given in support of a program to assist the Agricultural Bank staff in managing and supervising a wholesale operation. Furthermore, the project component should include technical assistance and training to the local groups in credit management and promotion of financial literacy.

(c) Cost

The cost of this component is depicted in Table 4.3.1. In addition to the line of credit it would be necessary some equipment to monitor the operation such as computers, fax and photocopier. This component would demand for a cadre of people to supervise the credit program. This would include a manager, credit officers and an accountant. Part of that personnel could be supplied by the Agricultural Bank, but other need to be hired by the project component.

The interest rate charged would make the program operationally and financially viable. The interest rate charged by the Agricultural Bank would cover the cost of delivering and administering the credit line. Similarly, the percentage charged by the financial intermediaries would be sufficient to cover their operation expenses. To ensure satisfactory economic impact, uneconomic proposals would be rejected.

This project component would help to increase credit access to rural residents in the study area and reduce the cost of borrowing which currently is significantly high and inaccessible to most of the residents in the study area. This would have a significant impact on the level of investment on the area, employment and income generation.

Similarly, it is expected that local financial intermediaries such as NGOs, water user associations, and Cooperatives would be strengthened institutionally and would boost their capacity to deliver credit to rural residents in the area.

This pilot project could also serve a show-case for innovative policies- such as the provision of untargeted and market-oriented financial services to rural communities in the country.

(3) Fund for the Rural Poor

(a) Proposed Activities

Financial resources from this credit component should be provided to poor segments of the population in the study area under market conditions but also with a commitment to environmental sustain ability. The credit provided would finance rural non-farm production with short gestation and daily sales such as poultry farming, petty trade and pig or goat keeping, cow fattening, pottery, and other related activities to individuals or households.

The borrower would have freedom to choose the activity to be financed by the loan. in order to be eligible for a loan, the borrower should be a small or micro rural entrepreneur (small scale farmer, sharecropper, artisan, or small trader or merchant). It would be also required that the borrower be a resident of the community where the investment would take place.

It is the intention that local financial institutions (community based groups such as women's associations, youth associations, NGOs and Cooperatives) start with small loans and provide repeater loans of increasing amounts as long as repayments of earlier loans are satisfactory. This aspect is critically important because the poor need to have continuos access to credit, in increasing amount, for a sustained period of time to accumulate enough saving/assets to escape from the poverty trap.

Some amount of the funding contribution could be the allocated for reforestation purpose in the upper part of the river basin using local people. Similarly, this fund could finance small specific experiments and research activities carried out by CIAZA that include adaptive agricultural research in communities to experiment with new varieties and crops, agricultural processing and other similar activities.

(b) Organization and Management

It would be necessary to establish a single channel of credit that administer the funds and dispense credits to members. The Special Fund for agricultural Development (FEDA) is the institution proposed (see Figure 4.3.2). External financing would be needed initially in the form of a grant or long-term loans with minimal interest rates. This Capital should be leveraged with government budget allocation.

It is suggested that a Trust Fund to assure sustainability in the supply of funding for this credit line should be created. In the case of FEDA, the part of the funding that have to be disbursed by the Central Government within the fiscal year could be allocated to this trust fund and disburse the fund over a longer period. This Trust Fund could be managed by a non profit organization or Foundation legislated by the government. The Foundation would take part of the interest rate on loans to cover the costs of managing the service. The rest of the interest rate collected and the income derived would go to the accumulation of the fund.

FEDA should elaborate a special lending manual to be used to guide operation of this fund. The policy manual would define eligible borrowers and projects for financing. The finance intermediaries that would channel credits to small holders and rural residents would set the criteria for lending which should include: group organizational requirements, default measures, necessity of saving as part of the program and maximum loan limits.

There would be a special unit at FEDA to supervise and manage this line of credit and coordinate with local intermediaries in the study area.

(c) Cost

The cost of this component is depicted in Table 4.3.2. In addition to the line of credit it would be necessary some equipment to monitor the operation such as computers, fax and photocopier. This component would demand for a cadre of people to supervise the credit program. Part of that personnel could be supplied by FEDA, but other need to be hired by the project component.

The program would need high-quality professional assistance both in financial management and in support of income-generation programs. Similarly, it is suggested a program to update the financial institutions in the study area in loan appraisal, accounting, auditing, portfolio management, resource mobilization and other banking activities. Training would be needed for credit officials who serve in FEDA as well as the community groups, cooperatives and NGOs

The project's overall impact on strengthening FEDA and the community groups and small/medium NGOs and enhancing sustainability and accountability of their credit programs is expected to be significant.

It is expected that this program would supply credit to finance rural investment to groups such as women and young people who do not have access to any credit source to start up an economic operation. This in turn will also generate more employment of local people and increase the level of income and living standard of the residents in the study area.

Another benefit of the project would be the improvement in the effectiveness and efficiency of funding operating in the rural sector of the study area and reducing the cost of lending.

The Fund for the poor is a new initiative and there exists a high credit risk. However, the project would put emphasis on developing sound operational rules, staff training and promotion of financial literacy among the poor.

4.3.2 Plan for Extension and Research Services

(1) Basic Approach to Extension and Research Services

In the Dominican Republic there has been a progressive deterioration of public sector agricultural research institutions. This situation is partly a consequence of the budgetary restrictions derived from debt crises but also it is the result of what is perceived as the ineffectiveness of public organizations in reaching farmers, particularly small-scale producers, and meeting their technological needs.

In the study area there are two research centers, CIAZA and CIAS that have shown noticeable weakness to generate appropriate technology to increase agricultural production and use rationally the natural resource base.

In response to problems with pests and diseases, the private sector has developed some

form of research activities in the area. This type of research has been localized with some level of success.

A research foundation (FDA) has been another important institutional development. That institution was created to mobilize technological knowledge with problem solving orientation using a highly flexible, non bureaucratic administrative structure and to provide alternative sources of funding for agricultural research.

FDA has been working closely with both CIAZA and CIAS providing funding for specific research activities. Specifically, FDA has funded adaptive research on pigeon peas and red beans at CIAS and CIAZA. It also has an on-going project on Integrated Pest Management in conjunction with The Dominican Agribusiness Council (JAD), the Agro processing Business Association (AFCONAGRO) and SEA. Other research activities include the Development of planting materials for cassava and banana production in the study area.

FDA in a collaborative effort with the different agricultural government agencies and two academic institutions (ISA and UASD) is offering a master degree program on technology and agricultural research. Through this program, about 80 professionals with baccalaureate degree who work in government agencies (INDRHI, SEA, IAD, INESPRE) and the private sector are pursuing master studies.

Non governmental Organizations (NGOs) are becoming important institutional actors, particularly at the interface between technology generation and technology utilization. They are assumed to be instrumental in providing adaptive research and technical assistance for small farmers.

The profitability of small farmers in the study area depends on the development of yield increasing, affordable technology that does not degrade the natural resource base. Developing such technology will require continued investments in agricultural research.

Previous efforts between the private agribusiness firms and public institutions as well as the creation of a research foundation, are clear examples of the possibility of joint ventures for agricultural research at CIAZA. These initiatives contribute to overall research capabilities and the broadening of the funding.

In this project component it is suggested the strengthening of the research center located in Azua (CIAZA) as well as the experimental station in Palo Alto Barahona, while integrating all stockholders in the generation and deliver of technology.

(2) Strengthening of CIAZA Station

(a) General.

At CIAZA there is a lack of trained personnel and adequate infrastructure. This is aggravated by limited facilities and resources for education and training of

professional and technical personnel. It was estimated that researchers earn inadequate salary and lack benefits and incentives. Furthermore, there is not a career path for technical and professional staff. as well as inadequate support in terms of equipment, technical information, and continuing education.

In the case of budgeting it was found a lack of funding to undertake research activities and provide maintenance for follow-up functions (supervision, monitoring, measurement of impacts, feedback); and, inadequate provision for project operating and maintenance costs.

In relation to Organizational Structure there is a fragmentation of responsibility and authority at the national level. A centralized decision-making procedure and political interference have restricted authority local managers. Recently SEA created an administrative council to provide guidance to CIAZA. This council is composed of the following members:

- Vice minister for Research	Public Sector
- Research Director	Public Sector
- SEA Regional Director	Public Sector
- CIAZA Director	Public Sector
- Association of agro-processing companies	Private Sector
- Federation of Independent Farmers	Private Sector
- Federation of Farmers and Peasants	Private Sector

This council was appointed but it has not held any meeting so far.

In the study area there is the need to strengthen local institutional capacity to do applied research on dry areas and irrigation issues as well as natural resources conservation.

CIAZA owns land and physical facilities that can be used to launch a appropriate research program to meet the demand from the study area. CIAZA owns 1,110 tareas (68.64 hectares) for research experimentation, although a low percentage is used for that purpose as it is shown in the following table:

Commodity	Area (Ha)	Research Purpose
Banana	25	Production and seed multiplication
Plantain	6.25	Seed Multiplication
Pumpkin	3.12	Seed Multiplication
Cassava	3.12	Seed multiplication
Okra	1.56	Seed multiplication
Pigeon Peas	0.3	Introduction, adaptability and selection of varieties
Red Beans	1.56	Seed Multiplication
Ind. Tomato	0.37	Varieties resistant to white fly and germinivirus
Beet	0.125	Research on fertilization response
Sweet Potato	0.25	Adaptability and resistance to weevil
Drainage Problems	4.68	Not under production
Fallow	21.8	Not under production
Physical facilities	0.5	Offices, Labs

The Barahona experimental farm has about 200 tareas (12.5 hectares) and it is being used to grow cassava and plantain. The main constraints identified are low production, irrigation water problem and problem with salinity. This research station is well located in relation to the study area. It is in the middle of the sugar plantation of Barahona Sugar Mill. However, this area needs to be expanded and used to develop technologies for alternative use for the land currently used on sugarcane production.

Currently CIAZA has the mandate to lead research efforts on Industrial tomato, Musaceae and Pigeon Peas. CIAZA will have the mandate to work on research topics related to dry areas (including crop production, integrate pest management, irrigation issues, and forest activities). It would also engage in the production of certified seeds and seedling for the main crops produced in the study area. The Barahona experimental station should be expanded and managed by CIAZA.

(b) Project components

This project would include the following components: a) improvement of CIAZA institutional capacity; b) a training program for CIAZA researchers; c) strengthens CIAZA facilities to undertake research and, d) develop a sustainable source of funding for research activities at CIAZA.

(i) Improvement of Institutional Capacity

In order to improve the institutional capacity of CIAZA it is suggested that the creation of a management unit as well as including capable researchers should be performed.

For the direction and management of CIAZA a management unit should be created. It would be composed of representatives from the Government (Vice-minister for research, director for research and the SEA regional director), private sector (agribusiness companies who operates in the area), Farmer

Associations and Academic institutions. This administrative body should have the mission to define research priority and seek funding for research activities. This administrative body would also have the responsibility to oversee research and the screening process for the selection and appointment of the Center Director (see Figure 4.3.3).

To further strengthen the institutional capacity to undertake research activities it is suggested that qualified researchers should be included. This can be accomplished either by luring some researcher from the private sector or academic institutions to come work at CIAZA or by hiring researchers who are graduating from the on-going master program carried out between the Government, the Research Foundation (FDA) and Local Academic Institutions (ISA and UASD).

New research specialists are needed in the following areas: Nematology, entomology, plant pathology, virus specialist and agricultural economics. The project would provide funding to hire two researchers for the first two years.

(ii) Training of Researcher

The project also contemplates to strengthen CIAZA research capacity by providing training to the current research staff. Currently none of the research staff have post baccalaureate degrees. Technical assistance should be provided for this activity. This project component asks for training of six members of the current staff at the master level through the local training program.

(iii) Strengthening Facilities and equipment

In order to strengthen research capacity at CIAZA it would be necessary to acquire lab equipment to carry out adaptive and basic research. The equipment set would include microscope, tissue culture, dissection equipment, centrifuges and sterillizer. It would also include glassware, lab furniture and supply. This would be allocated in the soil lab and plant protection lab. (See Table 4.3.3).

Additionally, it would be necessary to include electronic facilities for research evaluation and dissemination such as computers, printers, presentation aids and fax. Similarly there is the need to refurbish the physical facilities to accommodate, the lab equipment and office space for researchers.

The projects also include purchasing of farm machinery (tractor and plow) for the Barahona experimental station.

(iv) Funding

In order to assure funding for research activities at CIAZA it is suggested that a Trust Fund to be supervised by the administrative body and managed by the CIAZA director should be created. Funding to feed the trust fund would come from the private sector, government budget allocation and grant or

special loans from multilateral donors or foreign countries' government agencies.

The trust fund would allocate part of the annual earning to research according to the research agenda discussed and approved by the different stockholders that gather at the administrative body. CIAZA could also undertake specific research activities that have already identified funding by the private sector or by research foundation. It can also devote part of the funding for seed and seedling production for the main crops in the study area.

In order to finance some research, the credit component could specialize financial resources in a trust fund. This fund would devote resources to finance research from local organization, Universities and NGO's. The research agenda would be established jointly by the different stockholders (farmers, NGO's, Government, private sector)

c) Costs

Major costs of this component include lab equipment with an estimated US$ 55,000. This should be allocated during the first year of the project. (See list of equipment). Additionally, there would be some demand for computers and field equipment such as tractors and implements (see Table 4.3.4)

Another cost associated with research activities would be hiring long term technical assistance to strengthen the research capacity of CIAZA.

The increase in the research capacity at CIAZA would result in the adoption and spread of better farming practices and modern inputs which in turn will increase production in the study area.

It is also expected a reduction in soil erosion and deforestation due to the development and implementation of appropriate farming practices by farmers located in the low and upper part of the river basin.

(3) Training Programs for Extension Workers

(a) General.

In the study area, extension activities are carried out by a wide range of organizations such as the government, the private business and non-profit sectors.

Private sector extension services generally focus on cash crops or sale of inputs (fertilizer, animal feeds and machinery). Private agribusiness firms hire extension specialists to manage field activities with multiple functions such as education and promotion, input supply, instruction on production, and enforcement of output delivery This is the case of tomato processing firms and fertilizer companies in the study area.

The inability of many farmer organizations, NGOs and local community

organizations to prepare and present sub-project proposals in a format acceptable to funding agencies has delayed and often prevented sub-project approvals and rural investments in the communities. Similarly, their lack of market information and market strategies, have prevented them from accessing better market outlets both locally and internationally.

There is the need to train extension workers in order to design sub-projects, carry out feasibility studies and prepare bankable sub-project proposals.

Extension to strengthen producers from an institutional and managerial stand point has been absent. Extension workers do not have the skill or the incentives to fill that gap.

The SEA extension Department has recognized the shortcoming of the extension services at the national and regional levels. Among the main constraints found in the study area are the insufficient number of extension workers and their lack of training. Alongside it was identified that extension workers did not have transport facilities to travel to the farmers plots as well lack of modern extension aids for technology transfer.

To address the above problem the SEA extension Department has launched a national training program for extension workers. For 1998, according to SEA annual operative plan, the extension department plan to organize and deliver 98 short courses for extension workers nationally. The Department also plans to deliver 40 workshops, 16 conferences, and one national seminar.

SEA has training centers in Barahona and San Juan. The Barahona center consists of two rooms with capacity for 44 people each as well as dormitories to accommodate 40 people. In addition the center has a kitchen/cafeteria with a capacity for 50 people. The training center has a 16 tareas (1 hectare) plot in Neyba devoted to grape production. In the case of San Juan the center can accommodate 50 people and also has dormitory facilities.

ISA has an outreach program and the Center for Rural Development (CADER) which has been successful training agricultural officials and the private sector in areas such as agricultural project design and implementation, Agribusiness management and farm budgeting.

In addition, there is the Natural Resources Department that is also the leading school in natural resources research activities and has been working on a project on the Yaque del Norte River Basin.

Another institution engaged in training extension worker is the state university (UASD) which is also participating in the collaborative program between the government and the private sector for the master degree program.

Extension workers need to be trained. The extension workers not only from the Ministry of Agriculture (SEA) but also from other government bodies, cooperatives, and the NGOs that operate in the study area that will be involved with the delivery of services including credit.

In this project component, it is suggested a training program for extension workers for both, those who are already working in the area, and for new ones who could be integrated with the project.

(b) Training Program

Extension workers would be trained on four aspects: a) technical issues (crop production, soil conservation and management, water management, forest production and management, integrated pest management and sustainable farming practices); b) methodological aspects (use of audiovisual aids such as the use of computers, how to prepare a presentation with local inputs, overhead projectors, etc.); c) Managerial aspects (bookkeeping for farmers, farm planning, loan appraisal, accounting, auditing, portfolio management, resource mobilization and other banking activities) and, d) Organizational aspects (community participation, institutional strengthening for agricultural associations and marketing skills, Community Development and Plan and Program Evaluation).

This training would be carried out during the five years of the project and will include short courses, workshops, seminars conference and field trips as shown in Table 4.3.5.

Training will be offered to the extension workers by specialist on different subjects. The SEA extension Department will be in charge of the training program and will coordinate efforts with academic institutions such as ISA and UASD for the provision of trainers (See Figure 4.3.4). Similarly, the extension Department can make collaborative arrangements with other agencies engaged in extension training in the study area.

(c) Demonstration Farms

Demonstration farms would be set up at the two training centers in Barahona and San Juan help on the training of extension workers. Demonstration farms would be oriented to generate technical information. Those demonstration units would be used to show different technological practices mostly developed at the research center (CIAZA).

(d) Necessary Equipment and Facilities

Training centers in Barahona and San Juan would be used for the training activities. Although the centers have the physical infrastructure, some remodeling is needed. It would also ask for equipment and furniture. Equipment needed for the training component is listed in Table 4.3.6.

(e) Costs.

The cost for the training component totaled US$ 1.64 million. This amount would include US$ 0.5 million for training extension workers; US$ 80,000 for construction and refurbish the center for extension and training ; US$ 76,800 for communication and visual aids; US$ 760,000 for the monitoring unit. (See Table 4.3.7).

The project would finance the organization of training sessions; management service contracts related to the organization and conducting of training sessions; consultant services for training, and training expenses.

This project component would have visible benefits to the study area. Improving the institutional capacity to prepare projects, the project would lift one of the major bottlenecks for the financing of rural investments and significantly increase the investment pipeline of the funding agencies.

Likewise the training of extension workers would result in the provision of better extension services to the agricultural producers, and consequently, an increase in the production and productivity.

The project would also increase technical capacity to transfer technology to farmers and increase cooperative's capacity to adopt technology and become institutionally stronger.

4.3.3 Plan for Seeds Multiplication

(1) General

The production and distribution of good quality seeds by the Ministry of Agriculture in the entire Dominican Republic decreased from about 2,600 ton of seeds distributed in the year 1990 to about 1,950 ton of seeds distributed in 1997. The production of certify seeds by the private sector have been fluctuating up and down every year.

In San Juan area about 50 % of rice farmers use planting materials that they keep from previous harvest; Another 25 % of rice farmers obtain non-certified seeds from other farmers, and only about 25 % get relatively good quality seeds from private seed growers. About 50 % of bean farmers use good seeds that they obtain from the Ministry of Agriculture, but the other 50 % of bean farmers keep bean grains from their harvest to be used the following year as seeds. Also, majority of pigeon pea farmers use grains that they keep to be used for seeds the following year, and only about 12 % use certify seeds.

The extensive use of poor quality seeds and seedlings is one of the main cause of low yield and production of main crops obtained by farmers in the Study area.

(2) Target Production

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 with good quality certify seeds. The crops included in the plan for seeds production are rice, bean, pigeon pea, corn, and sorghum, and seedlings of plantain and banana. 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 (Ref. Table 4.3.8).

	Rice	Bean	Pigeon pea	Corn	Sorghum	Number of Seedlings/year	
	ton	Ton	ton	ton	ton	Plantain	Banana
Azua		86	12	20	8	0.9 million	0.37 million
San Juan	957	907	supply by CIAZA	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.

(3) Seeds and Seedlings Multiplication in CIAZA

The Center for Agricultural Research in Arid Zones (CIAZA) has been multiplying seeds and seedlings at small scale; The CIAZA has been multiplying seeds of pumpkin, okra, and read bean, and seedlings of plantain, banana, cassava, sweet potato, etc. It is proposed to enlarge and strengthen the capacity of CIAZA for seeds and seedling multiplication, in order to satisfy the requirement of seeds and seedlings of project areas in Azua, Yaque del Sur, and Lago Enriquillo irrigation districts. The CIAZA has about 65 ha of land for research and seed multiplication, part of which is often not been used intensively. Additionally, it is proposed that 200 ha out of the land area that will be released from planting sugar cane in Lago Enriquillo irrigation district is assigned to CIAZA for conducting research and seed multiplication. The economic benefit that could be obtained from the production and sell of certified seeds and seedlings by CIAZA may help to cover part of its research costs. The CIAZA will multiply seeds of bean, pigeon pea, corn, and sorghum, and seedlings of plantain and banana.

(4) Selection of Farmers for Seeds Multiplication

The association of Farmers of San Juan de la Maguana (APASJM), which has a total number of 180 members mostly medium and large scale farmers of San Juan irrigation zone, have been multiplying seeds of bean and rice under contract agreement with the Ministry of Agriculture. The total area devoted for seeds multiplication is bout 125 ha of bean and 150 ha of rice. These area represent only about 16 % of the area that should be dedicated to multiplication of bean seeds, and 56 % of the area needed for multiplication certified rice seeds for the future With project condition. It is necessary to expand and strengthen the capacity of the associations of Farmers of San Juan for them to dedicate the necessary area

for multiplication of certified seeds of bean and rice in the area of San Juan irrigation district.

(5) Necessary Equipment and Facilities

The equipment necessary for implementation of seed multiplication plan are summarized as follows:

Equipment	Characteristics	For CIAZA	For San Juan Farmers Association
Tractors		1 (45 HP)	4 (90HP)
Plowing Attachment		1	4
Seed Planter Attachment		1	2 for Rice and 2 for Bean
Harvester		1	2 for Rice and 2 for Bean
Corn Sheller		1	1
Pesticides Sprayer		2	10
Seed Classifier		1	4
Seed Packaging		1	4
Weight Scale		1	4
Tissue culture Lab	With capacity for 3.1 million seedlings per year	1 unit	
Truck		1	4
Power Generator		2 unit of 15 kW	4 units of 45 kW
Temperature and Air Humidity Control		1	4
Drying Floor		500 m2	5,000 m2
Storage building	Including cold areas	260 m2	3,000 m2

(6) Organization and Management

The organizational and managerial structure for seeds multiplication are already existing in the study area as explained above, named CIAZA and the association of Farmers of San Juan de la Maguana (APASJM); The two organizations are doing seed multiplication at present, but at small scale. These two organization will be strengthened and expand their respective infrastructure to do seeds multiplication at larger scale.

The CIAZA will receive a loan from the FEDA for development of necessary infrastructure and acquisition of necessary equipment for multiplication and handling seeds and seedlings. CIAZA will sell the seeds and seedlings at market price to recover the investments and repaid the loan.

The organizational structure of APASJM seems a viable organization for undertaking the implementation of seeds multiplication for the project areas of San Juan irrigation district; What is needed is to enlarge its infrastructure and number of equipment. APASJM will get a loan from the Agricultural bank for the enlargement of its infrastructure and to acquire necessary number of agricultural machinery and equipment. Also, APASJM will hire necessary technical assistance, including seeds multiplication specialist and managerial staff from an NGO.

(7) Costs

The total costs for seeds and seedling production plant in CIAZA and APASJM are summarized as below (Ref. Tab 4.3.9).

Unit 000' DR$

Item	CIAZA	San Juan, APASJM
Building and Drying Floors	2,840	14,000
Machinery and Equipment	2,082	5,946
Miscellaneous Costs (10%)	492	1,994
Annual Replacement	208	594
Annual Operation Cost (Seed Production)	3,468	15,527

4.3.4 Plan for Agricultural Cooperatives

(1) General

Cooperatives are characteristically handicapped by the lack of their own capital, and by the necessity of group decision making. The level of development and institutional capacity of cooperatives is significantly low in the study area. In the case of water user associations their main objective is to make better use of irrigation water and maintenance of irrigation facilities. Those types of organizations do not undertake other type of tasks related to agricultural production such as input supplies and marketing activities.

One of the major constraints expressed by farmers in the study area was the inability to get fair prices for their products due to the fragmentation of production and the fragility of the market system in the area. Producers face problems bringing their produce to markets and therefore are often in a precarious situation in establishing and maintaining their market position. This fact was aggravated by the absence of storage and processing facilities in the study area which contributed to high post-harvest losses and the necessity to sale right after harvest when prices are at their lowest point.

Additionally, it was found that prices received by farmers are undercut by the absence of a transparent grading and weight system. Farmers rely on middlemen for selling their production on an individual basis and middlemen have some monophonic power in setting up procurement prices.

In the lower part of the river basin operate a significant number of small associations but farmers' participation is very limited. They do not have infrastructure to handle production nor they offer any marketing services to their members such as storage, transportation, processing and buying of their member agricultural production.

There also exist a few farmer federations with provincial coverage which some level of institutional organization. This is the case of Federacion de Productores y Campesinos (FEPROCA) and Federacion de Campesinos Independientes Mam· Tingo (FECAIMAT) in Azua and the Asociación de Productores Agricolas de San Juan (APASJM). In the upper part of the river basin, the majority of the coffee growers do not belong to organized farmer groups.

The Dominican Agribusiness Council (JAD) has an on-going pilot project that has been successful integrating farmers to convert them into small entrepreneurs. The pilot project focus on increasing competitiveness and productivity of small and medium farmers in four provinces (Espaillat, La Vega, Peravia and Azua).

The project components include technical assistance, management practices and the provision of market information and market access support. In terms of market information, the pilot project provides weekly information on local prices for agricultural products at the different level (farm gate, wholesale and retail); information on input prices (fertilizer, chemical inputs, machinery service, interest rate;. information on potential buyers of their product as well as their credit history. Another type of market related services provided by the project are feasibility studies for alternative crops and technical information on Integrated Pest Management, animal feed, crop budgets and animal health.

Due to the low managerial capacity of farmer organizations and their inability to provide market services to the farmers in the study area, it is necessary to include some activities to develop a guarantee market as well as improve the market position of farmers. There is the need to develop a strong farmers' marketing organization that can increase and stabilize prices for output, develop storage and transport facilities and subsequently reduce marketing cost in the study area.

(2) Prospective activities and Proposed Organization

The project would focus on identifying activities that would strengthen the capacity of farmers' cooperatives in two critical areas:

a) Development of cooperatives' capacities for agricultural production procurement and distribution from small farmers in the study area;
b) Development of cooperative's capacities for processing/ marketing through crop storage, silage, harvest organization, transport, sales of agricultural commodities and, installation of agroprocessing facilities.

One alternative to do that is through an umbrella institution or private marketing board composed of farmer federations from the study area. All farmers would belong to this private marketing board through their cooperatives at the village level. The umbrella institution will provide different kind of services such as procurement for the production obtained in the study area, storage facility and transportation. The organization structure suggested is depicted in Figure 4.3.5.

The marketing board would have access to start-up funding for procurement and investing on marketing infrastructure (storage, transport equipment and agroprocessing) from the Rural Development Fund to be administered by the Agricultural Bank.

Professional expertise would be required to implement and maintain these activities. Marketing is the field in which experience and education are in short supply in the study area and so demand for specialized assistance. The project would provide funding to hire a

cadre of professionals and create a unit that would provide technical assistance to the marketing board for the first three years of the project.

The technical unit would work closely with farmers' federations in the study area on the establishment and development of the marketing board. This unit would also work with federations' leaders to train them on marketing and managerial aspects such that the marketing board will sustain its activities well beyond the project' life.

Additionally, this unit should work on the development of standardization and quality control for the agricultural production as well as on the identification of market both locally and internationally. The marketing board would make use of the Market Information System established in the study area to make decisions on when and to whom the production will be sold.

(3) Necessary Equipment and Facilities

The project would furnish computer facilities for the establishment of the marketing board. It is also necessary to rent office facilities to headquarter the operation of the marketing board. This office should be located close to the farmer production sites. It is suggested that the physical infrastructure should be located in Azua due to its strategic position in the study area.

The project would demand storage and processing facilities that could be built or rented by the marketing board. Similarly, it is expected a demand for transport equipment such as light trucks and trucks.

(4) Costs

The project would finance office equipment and vehicles, staff training in organization, management and technical matters and incremental operating costs as presented in Table 4.3.10.

The project would finance institutional strengthening of cooperatives through the provision of short courses on credit management, marketing and management . The project would also provide funding for field trips for federations' leader to have first hand experience on market in other part of the country. It is expected that at least 300 members of farmers cooperatives in the study area will be trained on these subjects.

It is expected an increase in the number of cooperatives involved in marketing and other non farm activities. The reduction on marketing cost and the increase of farm prices would result on higher income for farmers in the study area. Additionally, the provision of marketing services by the marketing board would result on a reduction of post-harvest losses and consequently a greater supply of agricultural production from the study area.