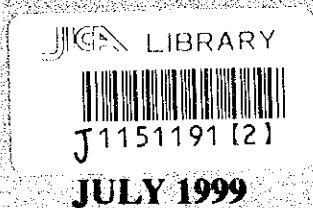


JAPAN INTERNATIONAL COOPERATION AGENCY
NATIONAL INSTITUTE OF HYDRAULIC RESOURCES,
THE DOMINICAN REPUBLIC

THE STUDY
ON
INTEGRATED RURAL DEVELOPMENT PROJECT
OF
YAQUE DEL SUR RIVER BASIN
IN
THE DOMINICAN REPUBLIC

Volume I

MAIN REPORT



Nippon Koei Co., Ltd.
Pasco International Inc.

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THE STUDY ON INTEGRATED RURAL

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List of Reports

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**MASTER PLAN STUDY ON THE AGRICULTURAL
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CURRENCY EQUIVALENTS

**US \$1 =Dominican Peso 14.0 = Japanese Yen 126
as of February 1998 (Master Plan Study)**

**US \$1 =Dominican Peso 15.5 = Japanese Yen 112
as of January 1999 (Feasibility Study)**

PREFACE

In response to the request from the Government of the Dominican Republic, the Government of Japan decided to conduct the Study on Integrated Rural Development Project of Yaque del Sur River Basin and entrusted the study to Japan International Cooperation agency (JICA).

JICA sent to the Dominican Republic the study team headed by Mr. Kenjiro Onaka, Nippon Koei Co., Ltd., four(4) times between November 1997 to May 1999.

The team held discussions with the officials concerned of the Government of the Dominican Republic, and conducted field survey and investigation in the study area. After the team returned to Japan, further studies were made and this report was prepared.

I do hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Dominican Republic for their close cooperation extended to the team.

July 1999



Kimio Fujita
The President of
Japan International Cooperation Agency

July 1999

Mr. Kimio Fujita
The President of
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Dear Sir,


We have the pleasure of submitting herewith the study report on the Integrated Rural Development Project of Yaque del Sur River Basin in the Dominican Republic, in accordance with the terms of reference issued by your Agency.

The study was carried out for a total period of 17 months from November 1997 to March 1999. The study was carried out in two phases. In the first phase, the master plan on the agricultural development in the Yaque del Sur River Basin was basically formulated with the principal aims of the increase of agricultural production and the improvement of farmer's living standards in the Yaque del Sur river basin through (1) agricultural development, (2) strengthening of agricultural support services, (3) establishment of overall water management system, (4) improvement of irrigation and drainage systems and strengthening of water user's organizations, (5) improvement of rural infrastructure and (6) environmental conservation. In the second phase, the feasibility study on the agricultural development in the lower Yaque del Sur that was the highest priority project selected in the master plan, was conducted. The project is judged to be technically sound, economically feasible, financially justifiable and environmentally sound. After implementation of the project, it is expected that the project will provide stabilization of the farmer's economic situation by increasing farm income, improvement of life quality of the farmers and creation of job opportunity for local people and improvement of social welfare. Therefore, we would like to recommend that the project soon be implemented in line with the conclusion present in this report.

We do hope this report will be helpful for promoting the national agriculture as well as regional socio-economic development plans conceived by the Government of the Dominican Republic, and to be of any services to prosper the cordial relations and good-will between Japan and the Dominican Republic.

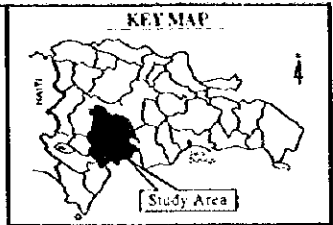
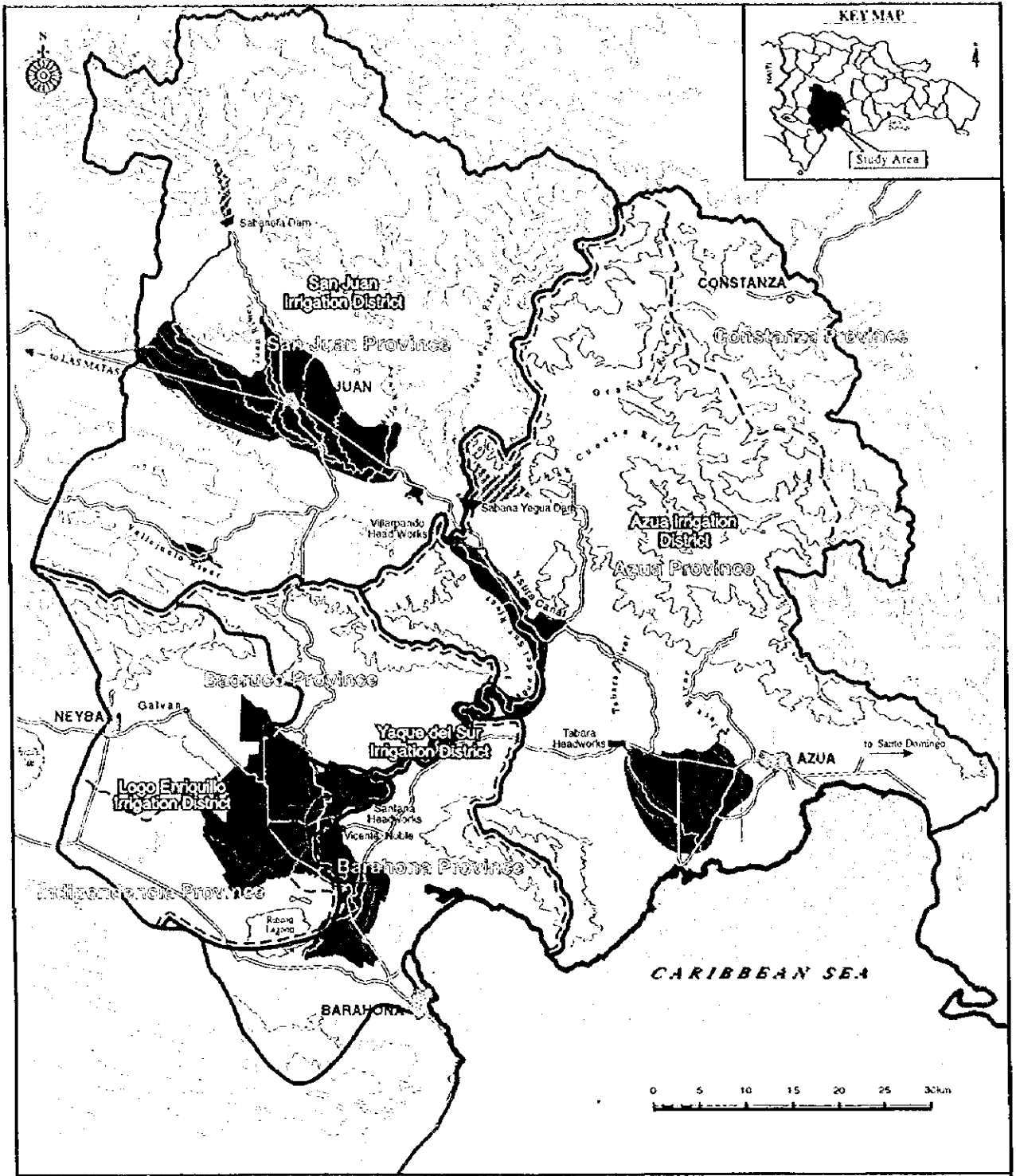
We wish to express our deep appreciation and gratitude to the personnel concerned of your Agency, your Office in the Dominican Republic, the Embassy of Japan in the Dominican Republic and National Institute of Hydraulic Resources for the courtesies and cooperation extended to us during our field surveys and studies.

Very truly yours,



Kenjiro Onaka
Team Leader

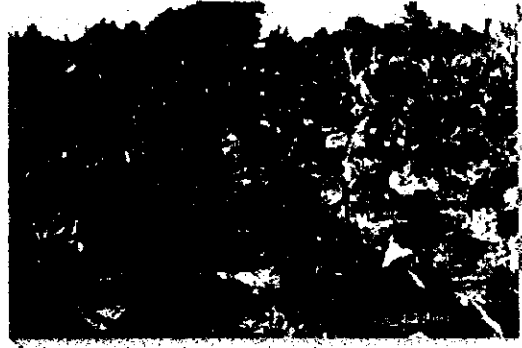
The Study Team of the Study On
Integrated Rural Development
Project of Yaque del Sur River
Basin in the Dominica Republic



LEGEND					
	Boundary of Study Area		Village		Province
	Irrigation District Boundary		Dam		
	Provincial Boundary		Headworks		
	Road		River		
	Canal		Contour		
	Existing Irrigation Area				



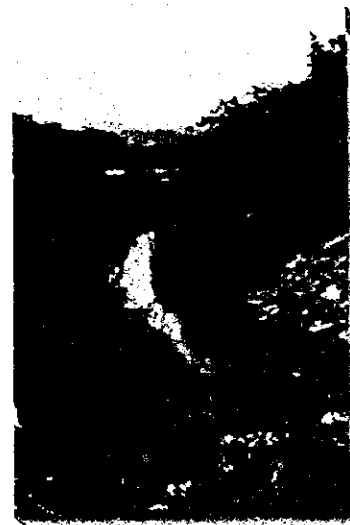
Condition of the existing irrigation canal



Plantain and Intercropping system with Chili



Present condition of the irrigation canal and turnout in Uvilla canal, Vicente Noble area



Existing earth canal in Vicente Noble area



Sand flushing gate at Villarpando Headworks



Villarpando Headworks (view from the upstream)



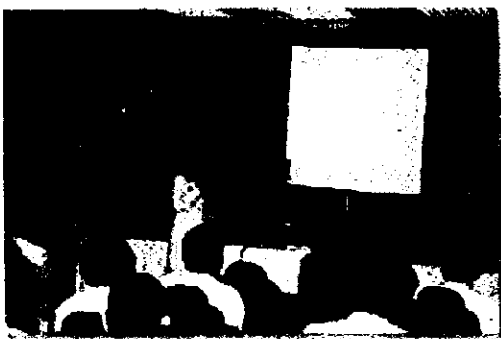
Yaque del Sur river (view of the upstream area)
and Santana Headworks



Sand flushing gate in Santana Headworks



Deteriorated portion in Santana Headworks



Workshop (explained by counterpart)



Yaque del Sur river near Canoa town
(view of the downstream area)

THE INTEGRATED RURAL DEVELOPMENT PROJECT OF THE YAQUE DEL SUR RIVER BASIN

SUMMARY

INTRODUCTION

1. This is the report which the JICA Study team prepared in accordance with the Scope of Work (S/W) for the Study on the Integrated Rural Development Project of the Yaque del Sur River Basin in the Dominican Republic (the Study) agreed upon between the Government of the Dominican Republic (GORD) and the Japan International Cooperation Agency (JICA) on July 2nd 1997. The Study was to be carried out in two phases, from November 1997 to June 1998 for the master plan study on the integrated rural development in the Yaque del Sur River Basin, and from November 1998 to March 1999 for the feasibility study on the priority area selected in the master plan. This report presents the results studied in both phases.

PROJECT BACKGROUND

2. The Dominican Republic is a small island country, which has one of the highest population densities in Latin America, and this high population density is putting very high pressure on the use of its land resources. Though agricultural and livestock production comprises only 14% of GDP, it provides employment for about 40% of the total economically active population in the entire country. Approximately 65% of the country's total export comes from the agricultural sector, which indicates that the Dominican Republic is still an agricultural country. Considering the country's economy from a long-term viewpoint, revitalization of the agricultural sector including generation of more employment opportunity is the most important goal to be obtained by the Government at the moment. All these factors conduce to the conclusion that a very high priority must be given to the sustainable development of the scarce land resources of the Dominican Republic.

PHASE - 1. MASTER PLAN STUDY ON THE AGRICULTURAL DEVELOPMENT IN THE YAQUE DEL SUR RIVER BASIN

PRESENT CONDITIONS IN THE STUDY AREA

Administrative and Social Condition

3. The Study area is the most underdeveloped area in the country and its total area is about 7,100 km². Administratively, the Study area is under the full or partial jurisdiction of 6 provinces, 29 municipal districts and 150 rural sections. The four provinces of Barahona, Bahoruco, San Juan and Azua occupy most of the area. The total population and the total number of the households of the Study area were an estimated 610,000 and 143,000, respectively in 1993. The number of farmers' households was an estimated 70,000.
4. The unemployment rate in the Study area is estimated at about 50%, as compared with 18% for the whole country, which is of great public concern. Increasing employment opportunity is therefore considered one of the top urgent issues. The illiteracy rate is also high, being estimated at 28-36% in the Study area.

5. As for the public services, the Study area belongs to the most disadvantaged region in the country in terms of services to basic human needs. It is estimated that a great percentage of the population live under poverty and do not have access to basic services such as rural electrification (only 69% receive), potable water (38%), toilet (28%) and collection rate of garbage (68%), which is 10% lower than that of national level.
6. Farm size of the farmers is small. The average farm size of the irrigated farmers is 2.32 ha. Farm sizes vary depending on location. The farmers in San Juan irrigation district have an area of 3.5 ha on an average; on the other hand, farm size in Azua, Enriquillo and Yaque del Sur irrigation districts is about 1.7 ha. Annual incomes of the irrigated farmers are estimated at about DR\$41,000 in San Juan, DR\$53,000 in Azua, DR\$35,000 in Yaque del Sur and Lago-Enriquillo irrigation district, while the incomes of the rainfed farmers are lower and unstable. Incomes of the farmers in the Study area are far below the national averages.

Meteorology and Hydrology

7. The main limiting factor to agricultural development of the potential irrigable lands is the scarcity of water resources. The climate in the Study area is semi-arid, where average annual rainfall is 500 mm to 900 mm. The annual rainfall is 930mm in San Juan, 660mm in Azua, 470mm in Neyba and 460mm in Barahona, which is increasing from north to south. The rainfall is very erratic with considerable variation year by year and most rainfall concentrates in several months during the rainy season. Mean annual evaporation is high at an estimated 2,000mm. These climatic conditions have hindered agricultural development.
8. The discharge of Yaque del Sur River is controlled by the Sabaneta and the Sabana Yegua Dams. Mean annual minimum discharge released from the Sabana Yegua Dam is about 20m³/sec and the annual minimum discharges in the downstream is observed at 17m³/sec at the Los Guiros and the Conuquite gauging stations.
9. Total volume of potential water sources is estimated at 1,680 MCM/year consisting of 1,430 MCM of surface water and about 250 MCM/year of ground water. While, 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. Needless to say, all of the potential water cannot be used. The water balance study indicates that available water resources are short by about 10 % against the present demand.

Land Capability

10. There is about 175,000 ha in total of classes II to IV in land classification of USDA in the Study area, which account for 24.7 % of the Study area. These areas mainly distribute in the central part of San Juan province, the south part of Azua province and in the lower reaches of the Yaque del Sur River belonging to Bahoruco and Barahona provinces (Refer to General Map). Most of the areas have relatively gentle topography. Of this total land area, approximately 71,000 ha or 41% have been provided with irrigation facilities. The remaining area (75.3%) is classified into V to VIII of which most are extended to the very steep and undulated area and are not suitable for irrigation farming.

Agriculture

11. Land use in the Study area is summarized in the following table :

Land use	Area (ha)	%
Agricultural land	271,000	38.1
Irrigated	71,000	10.0
Rainfed	46,000	6.5
Shifting cultivation & pasture	154,000	21.6
Forest & bush	394,000	55.4
Forest (dry)	175,000	24.6
Forest (wet)	84,000	11.8
Bush & shrub	135,000	19.0
Non-agricultural land	46,000	6.5
Total	711,000	100.0

12. Main agricultural products in the Study area come from the irrigation area consisting of about 71,000 ha. Major crops in that areas are rice and beans in San Juan Irrigation District area, banana and tomato in Azua Irrigation District area, and plantain, banana and sugar cane in Yaque del Sur - Lago Enriqueillo Irrigation Districts area. Major products in the rain-fed agricultural lands in the hilly and the mountainous area are corn, pigeon pea and coffee, while major products in the shifting culture/natural pasture land of 154,000 area are corn and pigeon pea. Shifting cultivation is performed in 3 year intervals.
13. The unit yield of crops is low not only in the rain-fed land but also in the irrigation area as shown in the table below. It is technically assumed for both lands 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, and (4) difficulties of the land preparation. In addition to (1)-(4), in the case of the rain-fed land including shifting cultivation the causes include (1) insufficient and unstable rainfall, and (2) deterioration of soils in land. Insufficient irrigation water and poor water management in the irrigated land cause low yield. The cropping intensity is about 60 to 120 % a year and averages about 80%. The main causes for the low multi-cropping index are considered to be (1) low availability of irrigation water, (2) low capability of purchasing proper amount of farm inputs such as fertilizers, seeds, chemicals, and so on and (3) shortage of tractors and their attachments for land preparation. As a result, agricultural productions are limited. The background of the above problems in the irrigated farmers are accrued from (1) farmers don't intend to apply the farm inputs sufficiently on their farm plots because they consider that they might not get irrigation water satisfactorily due to deterioration of existing irrigation facilities, inadequate water management and so on, (2) Access to the credits is very difficult due to no mortgage for loans, complicated procedure system of loan request, small available amount of loans of agriculture bank, high interest, and so forth. (3) farmer's low level of technology and farming practices (4) extension and support services to farmers are not sufficient. While, the background of the above problems in the rainfed farmers are accrued from (1) farm practices in the rainfed area to which the farmers apply are so poor that the farmers do not carry out the contour cultivation, a basic farming method for soil conservation, (2) the rainfed lands are usually located away from the extension service center, so that farmers can get few services from the center, (3) farmers in the rainfed area are so poor that farmers have no fund for purchasing farm inputs and access to loans of the agricultural bank is more difficult than that of the irrigated farmers. The yield of crops is shown below:

Crop	Azua Irrigation District		San Juan Irrigation District		Yaque del Sur Irrigation District		Lago-Enriquillo Irrigation District	
	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated
Plantain	13	18	12	17	-	18	-	18
Banana	13	26	14	24	12	26	12	26
Bean	0.3	0.9	0.4	1.1	0.25	0.9	0.25	0.9
Rice	-	2.5	-	3.0	-	2.2	-	2.2
Sugarcane	-	-	-	-	-	30	-	30
Tomato	-	25	-	23	-	24	-	24
Corn	-	2	0.9	2.0	0.8	1.8	0.8	1.8
Pigeon pea	0.95	1.7	0.95	1.9	0.87	1.3	0.87	1.3
Coffee	0.25	-	0.25	-	-	-	0.25	-

14. Total production of the major crops in the Study area are plantain (213,000 tons), banana (70,000 tons), bean (13,000 tons), rice (25,000 tons), sugarcane (264,000 tons), tomato (83,000 tons), corn (5,000 tons), pigeon pea (9,000 tons) and coffee (3,000 ton).
15. Large areas of land with steep slopes have been devastated due to the extensive cutting of trees and the existence of agricultural practices like "shifting cultivation". Especially, in the shifting cultivation, farmers cut trees in the national forests or shrub lands and illegally cultivate some crops on it at an interval of 3 to 5 years. The lands with the shifting cultivation are the poorest in vegetation, in which causes severe soil erosion and deterioration of soils themselves. Soils are eroded out with a rate of 2-2.6 mm/year/ km² in the upstream area of Sabaneta and Sabana Yegua dam. Such sedimentation problem has decrease the effective storage capacity of dams. In the irrigated field, sedimentation in the irrigation canal makes trouble and also soil erosion depressed agricultural land productivity in the upstream basin of the Yaque del sur river. The present disorderly use of hilly and mountainous lands should revert to a sustainable use of land.

It is estimated that there are about 26,000 shifting cultivation farmers or 37% of the total farmers in the Study area. According to the results of the rural rapid appraisal survey in Azua and San Juan area, such farmers are hoping to perform sedentary rainfed agriculture by means of an advanced farming practice instead of shifting cultivation. While, the Government plans to educate the sifting cultivation farmers on abolishment of their cultivation method, however the plan has scarcely been carried out actually.

16. Even if some areas have good quality soils, problems associated with low water availability, low rainfall, drainage and salinity prevent achieving the full agricultural potential of those soils. The population pressure on natural resources further aggravates these problems, which has brought about a deterioration of the natural resource fundamentals around the Yaque del Sur Basin.

Agricultural Support Services and Social Matters

17. Agricultural support services such as extension, research, seed multiplication, credit and agricultural information are one of the most important factors for farmers to properly increase agricultural production. At present, most of the governmental agricultural support services are poor due to lack of budgets, lack of necessary facilities and equipment. About 90 % of budget have been allocated to personnel expenses only.
18. The present extension work is carried out through the channel from Vice-Ministry of Research and Extension at Central SEA, region office, provincial office to sub-zone office. There are 178 extension workers in the Study area. The activities of extension work are limited due to (1) insufficient number of trained extension workers, (2) heavy work load of one extension worker, (3) lack of means of transportation and (4) lack of kid on extension services.
19. There are two Agricultural Research Centers (CIAZA in Azua and CIAS in San Juan) in the Study areas that are under Vice Ministry of Agricultural Research and Extension,

SEA. Over 90 % of the budgets of the Centers are allocated to personnel costs and it appears that research is not actually performed. Further the number of trained staff and equipment/facilities for research work are in shortage.

20. Most of the farmers in the Study area use seeds from the last harvest. Most seeds used are old and deteriorated, one of the constraints for low unit yield of crops. Though the Government has promoted increasing improved varieties through CIAZA research center and the agricultural cooperatives in San Juan, quantities of such seeds are small and insufficient.
21. Poor access to credit is one of the main constraints in agricultural production. In the Study area, the settlement farmers have received credit from the agricultural bank through the program prepared by the Agrarian Institute and IDECOOP. However, most farmers do not use the credit. The percentage of the farmers who got the bank loan is so low, it is estimated around only 2 % of the total farmers in the Study area. Most of the farmers who got the bank loan are the beneficiaries under the agrarian reform program by IAD. The reasons of difficulty of access to the bank loan are as follows; (1) Total loan amount of the Agricultural Bank is small, and so limited, (2) Farmers do not have mortgage for the loan, (3) Application procedure for the loan is so complicated, (4) There is not the group loan system and (5) An interest rate is as high as 18%/year. Thus the farmers are unavoidably financed by the money lenders
22. There are no organizations that systematically provide data and information about prices of farm input and outputs, location of sale and market, market requirement classified by grade, list and activities of dealers on agro-processing and machinery. SEA provides non-regular services of market information with farmers. At present, Agricultural Business Council (JAD) is undertaking the market information system in cooperation with SEA, custom office, Export Promotion Center, Suppliers of farm inputs, Associations of Farmer's Cooperatives, and so on. Under JAD in Santo Domingo there are several branches in which provincial agricultural cooperatives take part. Market information is exchanged between JAD headquarters and the branches. It is however not functioning well due to the shortage of necessary equipment, facilities and the system engineers.
23. There exist about 200 agricultural cooperatives and two federations of agricultural cooperatives in Azua and San Juan provinces. It is estimated that a participating rate to the agriculture cooperative in the Study Area is as remarkably low as approximately 10%. Main activities of most agriculture cooperatives are the credit (savings, loan) business under the guarantee of the Government. Only limited numbers of agriculture cooperatives consisting mainly of rice and red beans cultivators in San Juan province are operating cooperative collection and delivery of crop production, cooperative purchase and processing businesses. Those cooperatives are relatively active in their business. In Azua province, there exist approximately 40 agriculture cooperatives consisting mainly of tomato and plantain cultivators and COOFEPACO which is a federation of cooperatives in the province. COOFEPACO represents the cooperatives as a receiver of the Government loans, and further it executes the contract with a tomato processing firm for contract basis cultivation of tomato, as well as negotiates tomato prices with Ministry of Agriculture. However, agriculture cooperatives are commonly composed of farmers who produce identical crops or lives in the proximity each other. Most of cooperatives are weak in every aspect of organization operation and delicate by the following reasons; (1) the members are so limited as less than 20, (2) since the size is small, the cooperative is not capable of carrying out cooperative collection and delivery of crops, cooperative purchase businesses, which are the most important roles of cooperative, (3) managing staff of cooperatives are insufficient in capacity of organization management and financial control and (4) the cooperative members

inclusive of managing staff are lacking of a sense of solidarity as a union of cooperative members and recognition of objectives of cooperative, which have been induced from the insufficient education and training services to be rendered from the Government.

Present Condition of Irrigation & Drainage Facilities

24. Total irrigable area in the Study area is estimated around 70,000 ha comprising the San Juan area (24,300 ha), Azua area (19,100 ha) and Yaque del Sur - Lago Enriquillo area (26,500 ha). The main resource of the San Juan area is the San Juan River and Sabaneta Dam which is constructed on the San Juan river. On the other hand, the Azua area and Yaque del Sur - Lago Enriquillo area are served by the Yaque del Sur River and Sabana Yegua Dam which is upstream of the Yaque del Sur River. The San Juan area is located upstream of the Yaque del Sur River Basin, and Yaque del Sur - Lago Enriquillo area is at downstream reaches of the river basin. The Azua area lies out of the Yaque del Sur River Basin, however the irrigation water consumed in the area is delivered from the Yaque del Sur River through a diversion structure (Villarpando headworks). Villarpando headworks is located at the meeting point of the Yaque del Sur River and the San Juan River, and splits the river water into the Azua area and Yaque del Sur - Lago Enriquillo area.
25. Sabana Yegua Dam and Villarpando headworks have structural defect on effective usage of water. Because of underestimated design capacity of the spillway against the actual floods, the water level of the dam in rainy seasons is required to be kept below 10m from the designed normal water level. At present, an ongoing study on the rehabilitation of the spillway is being performed by INDRHI. Villarpando headworks has difficulties in fairly diverting water due to different types of diversion structure: one is of orifice type (to the Azua area) and the other is of overflow type (to the Yaque del Sur - Lago Enriquillo area). In addition, gates on the each structure are deteriorated. Under such conditions, daily operation of diverting water at the headworks is actually executed without any control of water volume.
26. In San Juan Irrigation District, there was major investment for agriculture development in 1970's. And at present the rehabilitation project and the drainage project for the area suffered by salinity problems are ongoing. In the Azua area, irrigation facilities were established at the same time of construction of Villarpando headworks and YSURA Headrace in 1970's. The salinity problems recently appeared because of a rise of groundwater table induced by irrigation water in the lower area of Azua. Now INDRHI is promoting a drainage improvement project for mitigating salinity problems in this area. Azua Extension area has not been developed. Along YSURA Headrace, farmers installed small PVC pipes personally and took water illegally from the Headrace for a long time.
27. There are many small gravity irrigation systems, which mainly consist of free intake and earth canals, along the Yaque del Sur River from Villarpando headworks to Santana headworks. These systems can take sufficient amounts of irrigation water easily, thus there are not many complaints about the water distribution according to the interviews.
28. Santana irrigation system was constructed in 1916 at the right bank of the Yaque del Sur River in Yaque del Sur - Lago Enriquillo area. Until today, no major rehabilitation work has been executed after construction, thus facilities are very deteriorated. Salinity problems are observed in the area and 3,500 ha out of 12,000 ha are abandoned. At the downstream reaches of Santana headworks on the Yaque del Sur River, there are many small pump irrigation systems as well as Vicente Noble gravity irrigation system. Because of frequent power cuts, these pump irrigation systems cannot be operated based on an operation schedule.

29. The Study area is divided into 4 Irrigation Districts defined by INDRHI ; 1) San Juan Irrigation District, 2) Azua Irrigation District, 3) Lago Enriquillo Irrigation District which governs the right side area of the lower Yaque del Sur River Basin, 4) Yaque del Sur Irrigation District which governs the left side area and most of the right side of the downstream area of the lower Yaque del Sur River Basin. In the San Juan Irrigation District, the Water User's Organization (WUO), so-called the Sabaneta Dam Irrigation Committee, has been organized in the irrigation system of the right bank side of the San Juan River such as J. J. Puello irrigation system and Hato de Padre irrigation system and being introduced in San Juan irrigation system. In Azua Irrigation District, there is the first established WUO (YSURA Irrigation Committee) in the Dominican Republic in 1980's.
30. Operation and maintenance activities for irrigation and drainage facilities are undertaken i) by WUO in the area where the WUO is organized and ii) by INDRHI without WUO. The following problems exist in the operation activities: (1) lack of appropriate irrigation plans taking into the consideration of supply of available water resources and farmers' demands, (2) deterioration of irrigation facilities, which hamper the proper operation of water distribution (specially in the lower reaches of Yaque del Sur River), no existing regulation ponds (in the whole area), loss of water during night time, which causes water logging in the field, (3) water distribution is not executed on any the schedule, and (4) difficulty in the collection of water charge. Because of these circumstances, irrigation efficiency seems to be low. Farmers have stated that there is a shortage of irrigation water to their field. The reason for the shortage of the water is summarized as follows: malfunction of facilities, water loss caused by inappropriate operation, useless water distribution during night. The main problem of maintenance work is shortage of maintenance funds. These problems are observed in both areas managed by WUO and INDRHI. The collection rate of water charge in the area managed by INDRHI is around 5% to 12%; on the other hand that in the area managed by WUO is 70% to 80% recently. It is expected that WUO will improve more in operation and maintenance activities.

Intention of Farmers

31. The farmers' interview survey stated that the farmers feel they are suffering mainly from the drought and insufficient irrigation water, the price control of agricultural products by middlemen, and the fluctuation of farm gate price of agricultural products, and desire the improvement of irrigation and drainage facilities, and easy access to subsidized credit. (Refer to the following table)

Agricultural Products

Ranking by Farmers	Total Points	Problems
First	252	Availability to irrigation water
Second	231	Drought
Third	140	Access to credit
Fourth	107	Insect
Fifth	92	Soil fertility
Sixth	73	Lack of technical assistance

Market

Ranking by Farmers	Total Points	Problems
First	270	High control by local middlemen
Second	237	Farmgate price fluctuation
Third	103	Poor road conditions
Fourth	74	Lack of market outlet
Fifth	72	Lack of support service

Agriculture Development

Ranking by Farmers	Total Points	Desires and Demand
First	240	Construction of irrigation infrastructure
Second	148	Access to subsidized credit
Third	132	Construction of aqueducts
Fourth	108	Access to subsidized inputs
Fifth	80	Construction of community infrastructure
Sixth	74	Promotion of job creation activities
Seventh	60	New land settlement

32. In August 1996 the new administration defined the country's social and economic development strategy. The Government sector policy in agriculture aims at increasing food and cash crops and farmers' income level through various measures, namely, promotion of trade liberalization including the elimination of tariffs and price control, increase of credit access opportunity, consolidation of settlement support services, improvement of irrigation facilities and commission of O&M of irrigation facilities to water users, measures of land conservation, coordination between research and extension institutions.

MASTER PLAN ON THE AGRICULTURAL DEVELOPMENT PROJECT OF THE YAQUE DEL SUR RIVER BASIN

Development Constraints

33. Main constraints on the agricultural development in the river basin include poor rural infrastructures, lack of advanced agricultural technology and poor agriculture supporting systems, while other 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 in the dams, salinity problems, 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.

Basic Development Concept

34. It is essential that constraints and problems identified should be solved to develop integrated rural development effectively, taking into consideration government development policy and farmer's desires for development. The overall objectives of the Project are: (1) stabilization of farmer's economic situation, (2) improvement of quality of life of the farmers, (3) creation of job opportunities and (4) improvement of social welfare.
- (i) Soil conservation through the settlement of sustainable agriculture development in the rainfed areas and reforestation in the Yaque del Sur river basin.
 - (ii) Increase of agricultural production through the improvement of irrigated agriculture techniques.
 - (iii) Increase of cropping intensity through improvement of irrigation efficiency and effective use of river water, which will be attained by improvement of irrigation system, establishment and reinforcement of water users' associations (WOUs) and strengthening of river basin management.
 - (iv) Strengthening of agricultural supporting system for better management of rain-fed and irrigated agricultural system.
 - (v) Improvement of social infrastructure in the rural area.

(vi) Environmental conservation in and around Rincon Lake.

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

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

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

- (i) Rehabilitation and improvement of existing irrigation facilities, construction of new irrigation system, alteration of water supply system from pumping system to gravity system, construction of night storage ponds, and construction of operation and maintenance roads along the canal system.
- (ii) Establishment of WOUs with 3 tiers system and water users' groups at the on-farm level, and management, operation and maintenance of the irrigation system by WOUs.
- (iii) Rehabilitation of the Villarpando headworks and proper water distribution through the headworks to the Azua Irrigation District Area and Yaque del Sur - Lago Enriquillo Irrigation District Area.
- (iv) Realization of effective use of river water including two reservoirs through the establishment of Yaque del Sur Water Management Center, monitoring and evaluation of water distribution at the major check points by installing a telemetering system, and the direct/indirect operation of irrigation system and real-time adjustment of canal discharge based on the monitored and evaluated results mentioned above.

As a part of agricultural support services, a training program is to be first conducted with a main emphasis on the level-up of farming techniques of the extension workers. As for the agricultural research, it is intended to strengthen the CIAZA Research Center located in Azua province, which is one of the research centers operated by the Ministry of Agriculture. This center does not fully function at present because of shortage in its budget. For this strengthening, it is proposed to re-organize the center by combining the private fund and the government function, to train the researchers, to provide the station with an appropriate number of research instruments and facilities. For the agricultural credit, a pilot project is to be implemented to introduce a group investment. The seed multiplication is intended to be conducted at the CIAZA Research Station and by the private enterprises to suffice the requirement of improved seeds and nurseries after the project implementation. As for the agricultural cooperatives, it is intended to

establish agricultural unions in both Barahona and Bahoruco provinces, where there are no federation of agricultural cooperatives at present, to conduct the small-scale credit business both for credit and deposit and to manage the marketing system for agricultural products and farm inputs. In addition, the Yaque del Sur Farmer Marketing Board is to be established in the Study area to control the marketing activities in the whole basin. The existing federation of agricultural cooperative and agricultural cooperatives are to be strengthened under the project. The existing agricultural information system being operated by JAD will also be strengthened under the project.

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

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

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

With respect to the rainfed agriculture (including 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, solving the above constraints and problems inherent in or relating to the agriculture and applying the national development policy and farmer's intention for the purpose at stabilizing 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 and drainage facilities and establishment of the water users' 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 and distribution of the improved seeds/seedlings, improvement of the development and the delivery system of the practical technology, organizing cooperatives, including a collection and distribution system, strengthening of the agricultural market information system and 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.

AGRICULTURE DEVELOPMENT PLAN

Land Use Plan

35. The future land use pattern in the Study area should be based on three main factors such as land capability, water availability either from rainfall or irrigation and soil conservation. In the hilly area with steep slopes, natural pasture and shifting culture land of 154,000 ha and rainfed agriculture lands of 46,000 ha are causing serious problems of soil erosion due to the inadequate land use management. In order to promote the reforestation and adequate use of steep lands, this Master Plan proposes the development of a pilot project for reforestation of about 720 ha and the Coffee Production Improvement Project, which

includes about 7,200 ha of poorly maintained coffee plantations as described below. The rural people are expected, through these projects, to get basic technology and information for fixed cultivation instead of the present shifting cultivation. At present, the families of the shifting cultivation are estimated at about 26,000 households in the Study area. Based on the above technology and information, they are expected to earn cash income from not only the reforestation but also the fixed cultivation with suitable fruit trees and upland crops. Since the farm size of the shifting cultivation is estimated at about 2 ha, such land of 52,000 ha will be replaced with the fixed rainfed cultivation land and the remaining 102,000 ha will recover the forest in the long run.

36. In the irrigated area, the basic development concept is set up with the improvement of the crop intensity through the rehabilitation of the existing irrigation system instead of new land development except 6,540 ha in total consisting of the Galvan groundwater development project (540 ha) and the on-going INDRHI project (5,950 ha).
37. After the project implementation mentioned above, the land use in the Study area will change as follows:

Land use	Present (ha)	Proposed (ha)
Agricultural land	271,000	175,450
Irrigated	71,000	77,450
Rainfed	46,000	93,000
Shifting culture & pasture	154,000	0
Forest & bush	394,000	489,500
Forest (dry)	175,000	175,000
Forest (wet)	84,000	186,000
Bush & shrub	135,000	128,500
Non-agricultural land	46,000	46,000
Total	711,000	711,000

Food and Cash Crops Production Improvement Plan

Proposed Cropping Pattern and Farming Practice

38. The agricultural development plan for the 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 order to achieve these objectives it is necessary to implement projects and programs for introducing appropriate irrigation farming practices, including the use of improved crop varieties, good quality seeds and adequate level of fertilization.
39. For selection of the crops in the present study, it is not proposed to introduce new crops but the crops which are widely prevailing in the Study area taking into consideration the existing farmers' experiences and performances, actual conditions of research and extension services to the farmers and the support to the marketing services. As mentioned earlier, 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 districts. For formulating proposed cropping pattern, special emphasis on the following points are placed:
 - (i) 120 days improved variety of paddy is introduced instead of 150 days variety in order to minimize the irrigation water requirement.
 - (ii) 80 days improved variety of pigeon pea is also introduced instead of present 270 days variety in order to minimize the irrigation water requirement and to effectively utilize the rainfall.
 - (iii) Planting period of tomato for processing is fixed during cool season from beginning of October through March in order to minimize the damages due to pests and diseases.

- (iv) Planting period of red bean is also fixed during cool season from beginning of October through March in order to minimize the damages due to pests and diseases.
 - (v) Repeating cultivation of tomato for processing is prohibited in order to prevent from the damages due to the repeating.
40. Appropriate irrigation farming practices that comprise improved crop varieties (including cultured seedlings of banana and plantain), adequate level of fertilization and appropriate irrigation water management will be adopted.

Crop Production Plan

41. Irrigation is essential for the crop production in the Study area because of scarcity of rainfall as mentioned previously. The improvement of irrigation efficiency as a result of implementation of the proposed irrigation and drainage projects and Yaque del Sur water management center project will increase availability of irrigation water. It is proposed that future additional available water be used to achieve an increase in the cropping intensity as well as the crop yield in existing irrigated lands, instead of increasing the irrigated lands, following the present cropping pattern taking into consideration the farmers' experienced practices.
- (i) Considering the farmers' intention, annual cropping intensity should be decided based on the distribution program to each irrigation system.
 - (ii) Following the Government policy, the cropping area of the paddy, which has a high water requirement, remains unchanged.
 - (iii) For the sugarcane area in the Barahona and Enriquillo irrigation district, sugarcane production is controlled by applying the improved farming practices based on the capacity of the existing sugar factory.
 - (iv) Planting area of the banana remains unchanged according to the market forecast by the Ministry of Agriculture.
42. The target yield of each crop planted in the Study area is set based on the review of available local data, discussion with research and field workers, or international publications related to tropical agriculture. The anticipated yields of major crops with project condition are summarized as follows:

(unit: ton/ha)

Crop	Yield under present or without project condition	Yield under with project
Plantain	20	26
Banana	29	40
Rice	3.0	4.5
Bean	1.1	1.5
Tomato	25	30
Pigeon pea	1.5	3.0
Corn	2.0	2.8
Sorghum	3.5	4.5
Sweet potato	13	17
Cassava	9	12
Sugar cane	30	130
Coffee	0.25	2.0

43. The anticipated total production of major crops in the Study area after the full implementation of proposed projects is summarized below:

(Unit: ton)

Crop	Azua Irr. District (ID)		San Juan (ID)		Yaque del Sur (ID)		Lago Furiquillo (ID)	
	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project
Plantain	81,400	130,800	4,400	10,300	113,000	187,800	14,000	88,400
Banana	23,500	32,200	5,200	7,000	41,200	56,800	900	1,100
Rice	975	1,460	23,900	35,900	100	150	130	200
Bean	1,360	2,300	10,800	22,600	70	120	220	1,700
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	3,800	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
Coffee	1,600	9,500	375	375	-	-	1,050	5,700

Coffee Production Improvement Project

44. In the Study area there are about 12,000 ha of land planted with coffee. The majority of coffee plantations belongs to small holders. It is estimated that about 60 per cent of the coffee area is very old and deteriorated. The Coffee Production Improvement Project aims to increase coffee productivity in small and medium size farms and to increase farmers net benefit and improve the living conditions as well as to protect soils in the hilly area from erosion. 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. The strategy of the project is to (1) increase unit yield, (2) improve quality of products, (3) prevent of soil erosion, (4) enhance bargaining power of marketing and (5) improve rural transportation.
45. The project component comprises (1) formation and/or strengthening 180 small coffee farmer associations, (2) development of 2 pilot areas having a total area of 80 ha, (3) training for 4 coffee specialists and 15 extension workers, (4) construction of nurseries of 14.4 ha, (5) replanting old coffee plantations of 1.2 million trees, (6) construction of drying yard and a cold storage with a capacity of about 60 tons (7) procurement of equipment for pulping and cleaning coffee, (8) improvement of about 70 km rural roads and (9) introduction of improved farming.

PLAN FOR STRENGTHENING AGRICULTURAL SUPPORT SYSTEM

Plan for Credit Services

46. The basic concept of the credit plan is to apply a group loan system and reduce the handling charges. The Rural Development Fund will be instituted within the agricultural bank. In addition to this Fund, the Fund to the Rural Poor is planned to be instituted within the Special Fund for Agricultural Development (FEDA) that has carried out through trust fund on a small scale. This fund is invested in the poorest in the Study area through the local financial institutions such as women's associations, youth associations, NGOs, and cooperatives.
47. The Yaque del Sur Rural Development Fund will be instituted in the Agricultural Bank. The members of the Fund consist of 1 manager, 1 secretary, 6 credit/accounting staff, 3 credit officers, 1 lawyer and 1 accountant. The Fund will provide group loans with organizations such as water user's organizations (irrigation nucleus: about 20 members), agricultural cooperatives, NGOs, and so on. In the project, necessary office equipment will be procured. Training will be performed for the staff in this project. Capital of the Fund will be US\$ 5 million. With respect to the 'Fund for the Rural Poor', the staff of the Fund consists of 1 manager, 1 secretary and 3 credit officer. In the project, procurement of necessary office equipment will be undertaken.

Development of Practical Technology and Plan for Strengthening of Extension Services

48. The plan for strengthening and development of practical technology is to strengthen the research function of CIAZA that will provide basic technology necessary for the successful implementation of the proposed agricultural, and irrigation and drainage projects. For this purpose, CIAZA integrates all stockholders in the generation and deliver of technology. Also reinforcement of institutional capacity as well as equipment/facilities will be undertaken.
49. The 'Research Trust Fund' will be established to obtain research funds and efficient development of applied technology. Members of the Fund include governmental agencies, private sector (for example, agro-processing companies, and so on), academic research sector (ISA, UASD, and so on), water user's organization, NGOs, and so on. CIAZA will employ additional 5 staff. The capability of the present staff will be improved by training in the 'Master Degree Program' that is now performed by the Government, ISA and FDA, and various training/seminar programs. Procurement of necessary equipment and facilities for laboratory, and agricultural machinery will be undertaken. At the same time, expansion of the present experimental farms in Barahona from 12.5 ha to 200 ha is planned.
50. The basic concept of the strengthening extension services emphasizes improvement of the capability of the extension workers among above three constraints. For this purpose, education and training for all extension workers will be performed at the existing training centers at Barahona and San Juan.
51. All extension workers will be trained on four aspects: technical issues, methodological aspects, managerial aspects, and organization aspects. Professional staff of SEA and/or universities will be assigned as trainees. Training programs consists of short course program, workshop, seminars, conference, field trips, and so on. Procurement of necessary equipment and facilities for two training centers will be carried out.

Introduction of Improved Seeds and Seedlings and Supporting Plan for Seed Multiplication and Distribution System

52. An increase of production of improved variety is essential for successful performance of the proposed irrigation and drainage development projects. CIAZA and APASJM (association of farmers of San Juan de la Maguana) now undertake seed multiplication work. The basic concept of the project is to carry out seed multiplication by strengthening productive function of the existing two organizations. The objective seeds are paddy, bean, pigeon pea, maize, sorghum, plantain and banana.
53. The target of production for improved seeds is set to be paddy: 960 tons, bean: 990 tons, pigeon pea: 12 tons, maize: 105 tons, sorghum: 40 tons, plantain: 2.7 million seedlings and banana: 0.6 million seedling. CIAZA covers the seed and seedling requirement in Azua, Yaque del Sur and Lago Enriquillo Irrigation Districts and APASIM is in charge of seed requirement in San Juan Irrigation District. Cold stores are planned to be constructed at CIAZA with a capacity of 260 m² and APASIM with 2,900 m². Also tractors and related attachments are planned to be procured for farming.

Plan for Strengthening of Market Information System

54. The plan aims to strengthen the JAD market information system and to enable the farmers in the Study area to receive agricultural marketing information properly. The present member of the branches consists of only farmer's cooperatives. Participation of water user's organization, relevant agro-processing companies, and so on will be expected. In addition to the present branches of San Juan (San Juan Agricultural Cooperative) and Azua (COOFEPROCA) provinces, new branches at Barahona and

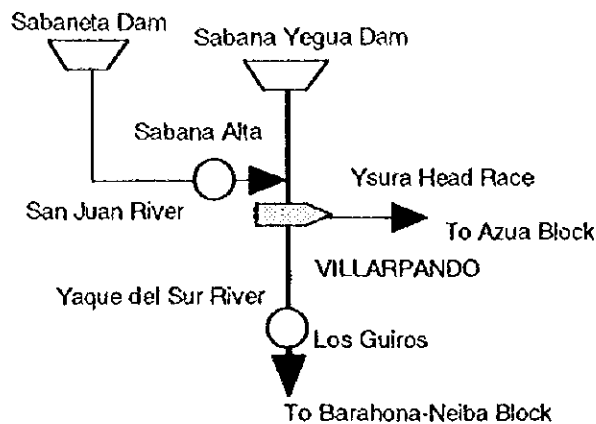
Bahoruco provinces will be established. The Barahona branch will be set up in Federation of Agricultural Cooperatives at Barahona city in Barahona province and Federation of Agricultural Cooperatives in Tamayo city in Bahoruco province that are proposed in the Strengthening of Agricultural Cooperative Plan. It is planned that communication and office equipment necessary for making market information system among JAD headquarters and four branches will be installed. Also education and training for system operators is essential for smooth operation of exchange of information between them.

Plan for Strengthening of Agricultural Cooperatives Including Cooperated Collection and Distribution

55. The basic concept of the project is to strengthen institutional capacity of cooperatives by setting up 2 new provincial associations at Barahona and Bahoruco provinces. Also an affiliation of the associations will be created at the basin level. Reinforcement of activities of the cooperatives should be carried out with an emphasis on cooperative purchase and marketing business.
56. This plan consists of (1) newly establishment of Yaque del Sur Basin association of the cooperative, (2) newly establishment of provincial association, (3) training and technical guidance for reinforcement of the new basin level and provincial associations and (4) procurement of the necessary and facilities.

Overall Water Management Plan

57. Organization for the overall water management in the Project area will be conformed to three (3) levels of management: inter-basin water management (Level-1), basin water management (Level-2) and irrigation area water management (Level-3).
58. Yaque del Sur Water Management Center is proposed near Villarpando headworks as a new organization for the Level-1 water management. Irrigation District Offices of San Juan, Azua, Lago Enriqueillo (Neyba) and Yaque del Sur (Barahona) will conduct the Level-2 water management. Field offices are proposed at Sabaneta Dam in San Juan and Santana headworks in Barahona-Neyba basin for ensuring prompt and accurate water management at control points. Existing organizations are utilized for this management level. The Level-3 water management will be done by the water users' organizations (WUO) which currently exist for several irrigation systems in San Juan and Azua areas. The WUOs are proposed for each irrigation system in the Project area.
59. Yaque del Sur Water Management center (the Center) will directly operate and maintain Sabaneta and Sabana Yegua Dams, and Villarpando headworks. The operation of the dams will be conducted in collaboration with the existing committees, namely, the Council for the Operation of Dam Basin and the Committee for the Operation of the Dam Basins.
60. Waters from Sabaneta Dam will be used for the San Juan area, while those from Sabana Yegua Dam will be distributed to Azua and Barahona-Neyba basins according to the proposed water demands in each basin. River discharges at Sabana Alta located at the most downstream reaches of the San Juan Basin, and Los Guiros located at the end of Azua Irrigation District area will be monitored and used for determining volumes of release at Sabana Yegua Dam, and water allocation to Azua and Barahona-Neyba at Villarpando headworks (see diagram below).



61. Standard storage curves, which are derived from estimated monthly water levels of the reservoirs in case of droughts of 1 in 5 years are proposed for ordinary operation of Sabaneta and Sabana Yegua Dams. The operation for the emergency or flood periods are proposed to follow the storage curves or water levels which have been set by the Emergency Dam Operation Committee (COBE). The operation of the dams will be carried out on the basis of the demands and controlled to maintain the water levels between the ordinary and emergency storage curves. The demands and discharge at Sabana Alta (inflow from the San Juan Basin) determine release volume from the Sabana Yegua Dam.
62. Operation of Villarpando headworks is determined based on the water demands at Azua and Yaque del Sur and Lago Enriquillo areas. In case water resources are sufficient against the demands, the demands for Azua will be diverted and the remaining waters will be discharged to the downstream. If the water resources are not sufficient, the waters will be divided according to the proportion of the demands. Discharges at Los Guiros will also be used for determining of the diversion rate at the headworks in order to secure certain amount of water for the demands in Yaque del Sur and Lago Enriquillo areas.
63. A telemetering system is proposed for the Level-1 water management. A flood warning system is proposed for Sabana Yegua Dam of which design flood is being revised and the emergency spillway will be rehabilitated for future operations. The telemetering system covers Sabaneta and Sabana Yegua Dams, Villarpando headworks, hydrological control points at Sabana Alta and Los Guiros as primary stations, and Tabara headworks and Santana headworks as secondary stations. Basic information/data such as rainfall, discharge of rivers and canals, water levels at reservoirs, and so on are collected by using the telemetering system, and the operation of facilities are proposed to be conducted manually at site giving/getting instructions and orders from the Center.

Irrigation and Drainage Development Plan

64. The existing Villarpando headworks will be improved by providing a discharging sluice equipped with roller gates at the left end of the existing overflow weir in order to fairly distribute river water between Azua Irrigation District area and Yaque del Sur and Lago Enriquillo Irrigation District area. Besides, all the existing gates in the intake and the sand flushing sluice will be repaired or replaced with new ones including motor-driven lifting devices. The level of water management proposes training programs. Training facilities and functions are attached to the Center, and the Center will conduct various training programs for each level. The Center will carry out training courses for staff of

Irrigation Districts, Field Offices at Sabaneta and Santana, and Irrigation Committees. Training of WUO staff and members will also be supervised by the Center.

65. In the Study area, most of the farmers are engaged in irrigated agriculture due to the scarcity of rainfall. The irrigation efficiency is assumed to be very low because of poor irrigation facilities and deterioration, few establishments and financially and technically poor water users' organization, inadequate operation of the facilities and ineffective irrigation in the evening as mentioned earlier. The water balance study indicates that water availability is tight even in the normal hydrological year under the present cropping in the area benefited by the Yaque del Sur River. It seems to be caused by poor water management and irrigation practices. The most important subject in this irrigation sector is, therefore, effective use of the limited water resources. In this context, it is essential to use limited water resources effectively, and hence, priority of the irrigation development should be given to the improvement of the water management of the existing irrigation system in order to stabilize farm management and improve the farmers' living standard.
66. In order to efficiently use water, besides the previously explained 'the Yaque del Sur Water Management Center',
 - (i) diversion structures and intakes, which are not working well, should be improved or replaced with new ones and free intakes should be improved by providing gated intake structures in order to exactly divert water to meet the scheduled amount,
 - (ii) water users' organization (WUO) enabling farmers to be more involved in the O&M of irrigation and drainage systems should be set up in each of or a group of irrigation systems and reinforced so as to be able to manage the systems by themselves and
 - (iii) the existing irrigation and drainage systems should be rehabilitated and improved, if necessary so that WUO receives the systems from INDRHI in good operation condition.

Rehabilitation and Improvement of Irrigation and Drainage Systems

67. San Juan irrigation zone and Azua irrigation zone have been relatively well developed since 1970s. At present, irrigation and drainage improvement and water management projects are being executed under PRODAS, PROMATRES and PROMASIR. Major existing irrigation and drainage systems left with no definite plans are prominent especially in the Yaque del Sur and Lago Enriquillo area where it is the most severe zone with a dry climate and less availability of water. Many of the systems require for rehabilitation and improvement. The Yaque del Sur and Lago Enriquillo area should be placed as a most important zone for the rehabilitation and improvement.
68. In addition to the rehabilitation and improvement of the existing facilities, night storage ponds are proposed to be provided near or in the irrigation fields in large scale irrigation systems in order to realize the efficient use at an on-farm level, so that the irrigation water is once stored in the ponds during nighttime and released during the following daytime from early morning to evening when farmers are working in the fields.

Major Irrigation and Drainage Projects

69. Major irrigation and drainage projects identified are summarized as follows:
 - All the irrigation and drainage development plans are subject to the management by WUO containing the establishment and reinforcement of WUO.

- Night Storage Pond Projects: Improvement of facilities with provision of night storage pond in major irrigation systems such as the Jose Joaquin Puello, the Hato del Padre, the San Juan, and the Mijo,
- Guanito San Juan System Improvement Project: improvement of the earth canal sections of about 8 km in the main canal and the provision of night storage ponds,
- YSURA Area Improvement Project: Repairing or replacement of damaged gates on YSURA conveyance system including Tabara headworks and improvement of facilities with provision of the night storage ponds in the YSURA area
- YSURA Extension Area Development Project: improvement with provision of concrete lining in the YSURA main canal in the lowest reaches and construction of irrigation and drainage system and groundwater development in the extension area.
- YSURA Headrace Small Irrigation System Improvement Project: replacement of the privately installed plastic pipes for diverting water from YSURA headrace with permanent intake facilities.
- Yaque del Sur Lower Reaches Irrigation and Drainage Improvement Project: improvement of all the irrigation and drainage facilities in the Santana irrigation systems and unification of small irrigation systems located along the Yaque del Sur River into a large-scale irrigation system by the provision of a main canal from the existing Santana headworks.
- Galvan Groundwater Irrigation Project: irrigation development area is assumed to be 540 ha in total with approximately 20 numbers of tubewells in the southern area along the Galvan - Neyba road.
- Yaque del Sur Small Gravity Irrigation System Improvement Project: improvement of small irrigation systems with provision of intake structures each equipped with a steel gate and a measuring device and canal system by lining in the reaches where seepage loss is large and accessible.

Operation and Maintenance Plan

70. A cropping program and an irrigation schedule are essential for proper water management. They should be prepared immediate before the cropping season. Based on the schedule, water is released from the dams and flow into the river and is then diverted at the intake of each of irrigation systems and conveyed through the conveyance system up to the night storage ponds on the 24 hour basis in the case of the large irrigation systems. Then, water stored in the ponds during the nighttime is distributed from the ponds and field canals to the fields during the daytime. In the small irrigation systems, it is proposed that water be diverted from the river to the fields during the daytime by daily operation of the intake gates.
71. The maintenance works are broadly classified into routine maintenance works and emergency repair works. The routine works are composed of routine inspection and maintenance works and minor repairing and rehabilitation works. In the maintenance period, probably once or twice a year, all water in the irrigation canal systems should be completely drained and dried up and damaged portions of canal inside should be repaired.
72. Small distribution and field canals will be maintained by farmers themselves of every Nucleuses as a communal work. Nucleus chief or representatives of member farmers will prepare a maintenance schedule for distribution canals and the correspondent drains containing an allotment of works to every farmer and the date of the works. Major irrigation facilities such as headworks, main and lateral canals, the related structures, night storage ponds, and major drainage canals will be maintained by the staff employed

by WUO with light equipment on WUO's responsibility. In case that the emergency repairing or a large-scale maintenance and repairing is required, the Irrigation District Office will assist WUO in repairing the damaged portion or to carry out the large-scale maintenance works mobilizing construction equipment owned by the Irrigation District office.

73. Both the Irrigation District Offices and the Irrigation Committees don't have nor compile systematically sufficient data of irrigation and drainage facilities and cadastral data of agricultural lands. They can not make detailed irrigation and maintenance programs. All the data of irrigation and drainage systems including the related structures and the cadastral maps indicating the agricultural area of every farmers and canal layout should be kept in a computer by use of an appropriate data base software. These data should be updated every year. Based on these basic statistics together with climate data, practical O&M programs can be made. Together with these data, an information system in and between the organizations should be established.

Organization of Water User's Organization

74. In San Juan Irrigation zone, the existing Sabaneta Irrigation Committee will extend the management to all the irrigation systems served by the San Juan River and Sabaneta Dam through the establishment of WUO in the San Juan and Guanito San Juan irrigation systems. All the Azua irrigation areas served by the Yaque del Sur River and Sabana Yegua Dam will be incorporated into the existing YSURA Irrigation Committee. It is proposed in Yaque del Sur and Lago Enriquillo Irrigation Districts area served by the Yaque del Sur that farmers are newly organized into WUO in each of irrigation systems and that an Irrigation Committee provisionally called the Yaque del Sur Irrigation Committee, of which jurisdiction is all the areas located in the downstream of the Villarundo served by the Yaque del Sur River is proposed.
75. As WUO is founded one by one irrigation system, some of INDRHI staff will be employed by WUO as technical and administration staff and INDRHI will commit WUO to carry out water management and maintenance of irrigation and drainage facilities. Under such a situation, all the Irrigation District and Zone Offices will be reduced especially in the Conservation and Improvement Unit, the Water and Soil Management Unit, and the Pump Operation and Maintenance Unit. The Conservation Unit may be unified to the Supervision and Investigation Unit.
76. The proposed WUO in each scheme will be basically similar to the present Sabaneta Dam Irrigation Committee. The main objective of WUO is to operate and maintain the irrigation and drainage facilities in order to use efficiently the limited water resources and to increase the agricultural productivity. The members of WUO are the water users of the irrigation systems. WUO will have an organization structure of the member farmers corresponding to the irrigation system level as shown below.

Nucleus	One distribution canal or a few field canals level: 1-50 farmers, 20-60 ha
Sub-committee	One night storage pond, one pump irrigation system level, or one or a few small independent irrigation system level: 50-500 farmers, 100-1,000 ha
Association	One large irrigation system, large lateral canal or a group of the small irrigation systems: 500-1,000 farmers, 1,000-10,000 ha
Irrigation Committee (Junta de Regantes)	One irrigation zone benefited by one river

77. WUO will employ technical and administration staff who actually assist WUO in preparing maintenance programs, irrigation schedules and directly carry out O&M in the conveyance systems including the proposed night storage ponds and administrative management including collection of water charge. Under the Board of Directors of an Irrigation Committee, a force of management staff will be organized under one manager.

78. Irrigation District Offices will be reduced in the staffing as the O&M works are committed to WUO. Only the conservation and improvement unit will be maintained in the same scale as present. The construction equipment is maintained and replaced as usual. In addition to the replacement in turn of already depreciated goods, computer sets should be introduced in every divisions in order to prepare and compile all the useful data and information and make the computer communication. WUO needs an office space, light equipment and tools for the water management and routine operation and maintenance works. In case of a large WUO, offices will be provided at each association level as a branch office in addition to a head office.
79. The O&M costs are approximately estimated at DR\$ 700 / ha in total. In addition to the costs, WUO will pay a certain amount to INDRHI for the O&M works.

Water Charge

80. In the early years from the establishment of WUO, the water charge may be controlled at a low price by subsidy from INDRHI. All the O&M costs, however, should be covered by the irrigation water charges collected from the farmers in principle. A per-capita water charge will be simply determined in each of two crop seasons a year in proportion to the individual scheduled irrigation areas based on the cropping program or more simply determined in proportion to the area of the agricultural land owned by each of farmers. The water charge will be collected before each cropping season. A nucleus chief will collect the water charges from the member farmers and pay the collected money into the bank account of WUO. To achieve a good progress on collecting water charge, it is recommended to include some punishment for non-collected charges and incentive in the by-laws.

Training for WUO

81. Training for WUO aims to attain sustainable water management by water users themselves through diminishing the present constraints. The training program aims to assist the setting up of WUO, to fortify the organizational structures of WUO and to expedite the commission of O&M and irrigation water management from INDRHI to WUO as well as to provide the water users with the technical, managing, legal and environmental knowledge for the proper and efficient administration in the irrigation system operation and water management under their responsibility. The training measures will contain lectures, educational videos, field practices, workshops, field trips, propaganda, as well as others. The training is firstly adapted to leading farmers playing an important role in setting up WUO and then extended to all the farmers.

Water Balance

82. Water balance simulations were conducted by hydrological basin, namely San Juan, Azua and Yaque del Sur - Lago Enriquillo irrigation district area. New water resource development was not assumed for the simulation. The water budget was examined using proposed conditions such as enhanced irrigation efficiencies, cropping patterns, and so on. The irrigable areas under the proposed conditions were estimated by irrigation area.
83. San Juan basin is treated as an independent block which can use the water resources without allocating any of available water resources to the downstream blocks, while Azua and Yaque del Sur - Lago Enriquillo irrigation district basins are dealt together for optimizing the water resources from Sabana Yegua Dam.
84. Irrigable areas, which mean total acreage to be irrigated for one year, under present and proposed conditions, are compared for each irrigation system. The irrigable areas by basin are summarized below:

Basin	(unit:ha)	
	Present	Future
San Juan irrigation district	23,997	36,144
Azua irrigation district	16,162	23,863
Yaque del Sur and Lago Enriquillo irrigation district	25,438	44,185
Total	65,597	104,192

Water Resources Development Plan

85. There are four prospective development projects, namely (i) the development project of José Joaquín Puello Dam, (ii) the rehabilitation and improvement project of Sabana Yegua Dam, (iii) Azua groundwater development project, and (iv) Neyba-Galvan groundwater development project.
86. José Joaquín Puello Dam is proposed along the José Joaquín Puello Canal at 15 km downstream of the beginning point. The catchment area of José Joaquín Puello Dam is very small of 9 km², and the water conveyed through the canal will cover a large part of the storage. According to the water balance simulation under the proposed conditions, water resource (in-flow) of 70 MCM remains available at Sabaneta dam after allocating 200 MCM to José Joaquín Puello, San Juan and Hato del Padre Irrigation Systems. A certain amount of the remaining water can be utilized by the operation of José Joaquín Puello reservoir. Detailed investigation and analysis especially on the geology and topography at the dam site will be required for further study.
87. The main component of the Sabana Yegua Dam Rehabilitation Project is the rehabilitation works of the emergency spillway. The maximum operating level of the reservoir is maintained almost 10 m below the crest level of the spillway at present during the flood months of August and September. The rehabilitation of the spillway and the raise of operation level will increase available water resources for Azua and Barahona-Neyba basins. Detailed study on the project is being conducted by INDRHI.
88. Azua groundwater development project is proposed to cover the extension area of the YSURA canal to the west of the Azua city. Discharges of 20 to 30 lit./sec are expected per tube well, which will irrigate 20 to 30 hectares of fields of upland crops.
89. Neyba-Galvan groundwater development project is proposed along the main road connecting Neyba and Galvan to the north of Neyba Valley. The development of wells will be determined taking into consideration the proper density of wells (1 for 1 km²) or groundwater table in the Project area. Discharges of 20 to 30 lit./sec are expected based on the existing tube wells in the area.

RURAL INFRASTRUCTURE DEVELOPMENT PLAN

Rural roads

90. Most of rural roads are not sufficiently maintained in the Study area due to the lack of financial resources, badly affecting the transportation of the farm products especially in the rainy season. Since construction of canal inspection roads are planned along the major canals in the present study which will be utilized as farm roads, improvement of the roads linking these inspection roads and villages are considered as the rural roads. Total length of rural road improvement is estimated at (1) 40 km for the rehabilitation of national rural road, (2) 248 km for the improvement of national rural road and (3) 141 km for the improvement of local rural road. Standard of the work includes repair of the impassable section, rehabilitation, additional pavement, shaping of unpaved road and repair / installation of road related structures.
91. Supply of maintenance equipment is included for the project in order to enable the local government to continuously maintain the farm road network. The responsible

organization is assumed to be public work section of the provincial office. Maintenance equipment to be procured under the project is estimated at bulldozer, backhoe, grader, dump truck, water tanker, macadam roller and their garages.

Rural water supply

92. The ratio of the rural water supply in the Study area is about 10% lower than the national average. Bahoruco province and the hilly areas in Azua and San Juan province are worth especially. INAPA has various plans and projects for the development of the rural water supply, and the projects are to be formulated within the framework of the national policy and INAPA program including the NGO's activities. In the present master plan study, a target is preliminary set up to achieve that the ratio of rural water supply catches up with the national average level, particularly in the depressed area.
93. Rural water supply systems included in the present study are (1) 7 water supply schemes by surface water (4 in Azua, 2 in San Juan and 1 in Bahoruco) and (2) 3 tube well schemes (in Bahoruco and 1 in Barahona). Construction work includes (1) tube well, 100 m and pump, 0.5m³/min. or intake facilities and settling basin, (2) supply pipe, (3) reservoir, (4) booster pump, (5) distribution pipe and (6) elevated tank.

Rural Electrification

94. Generation of the electricity in the Study area is absolutely short. This deficit would be covered by the development of new power stations. INDRHI has a strong intention to develop some hydropower stations, both dam projects and mini-hydropower stations in the Yaque del Sur River Basin. Since promising dam projects have not been identified based on the present water balance study, it can be said that the mini-hydropower development has some advantages considering its urgent necessity.
95. Based on the preliminary comparison study among José Joaquin Puello, Santana and Magueyal mini-hydropower potential schemes, the Magueyal scheme is considered promising in terms of power generation potential. For this scheme, it is planned that a mini-hydropower station be constructed on the existing YSURA Headrace utilizing the canal water taken at Villarpando headworks for power generation. After power generation, tail water is flowing to the tributary of the Yaque del Sur River and finally returned into the Yaque del Sur River, not affecting the water distribution for the proposed irrigation projects. However, this scheme is proposed to carry out more detailed investigation including topographic survey and geological study for early implementation. Present preliminary study shows that an installation capacity and annual possible power generation is estimated at 2,600 kW and 22 GWh respectively.

Supporting Facilities

96. For the present study on the river basin agricultural development, construction of the community hall and water user's Office are proposed in connection with the proposed agricultural development and the strengthening of water users' activities in the irrigation area. Proposed facilities to be constructed in each area are : (1) Seven water user's offices (4 in Azua, 2 in Bahoruco and 1. in Barahona) and (2) 19 community halls (9 in Azua, 3 in San Juan, 3 in Bahoruco and 4 in Barahona).

PLAN OF ENVIRONMENTAL CONSERVATION

Reforestation in the Upper Watershed Areas of the Grande River

97. The basin of the Grande River, which is one of major tributaries of the Yaque del Sur River flowing into Sabana Yegua Dam, is one of the most devastated basins causing severe soil erosion and sedimentation in the reservoir of Sabana Yegua Dam and not

incorporated into any conservation projects. The basin is 676 km² in total, of which 51 % is occupied by the natural pasture and extensive agricultural lands. Coniferous forest covers only 14 %. Small communities of about 42,000 people are scattered.

98. The most important concept of the project is to change the local people's role from agents who cause deforestation to agents who create and manage forests. For this concept, the local people should participate in all the stages of the project planning, the implementation, and the maintenance.
99. To establish the method of reforestation in the whole watershed of the Grande River, in this plan, a model area will be selected in the area of about 3,000 ha along the Arroyo Limon River, a tributary of the Grande River, where people practice shifting cultivation. The program will consist of the selection of useful trees, nursery construction, and care of seedlings and nursery trees, maintenance of trees, construction and improvement of access roads, and education and training of local peoples. Several small nurseries will be constructed instead of one large-scale nursery in consideration of advantage of transportation in poor access and difficulty of possession of the site. In the education and training, local people will learn the method of planting, management and maintenance, harvesting, processing, and marketing, particularly techniques for forest and soil conservation and techniques for the sedentary agriculture, which is essential in order to cease the shifting culture.
100. It is proposed that total reforestation of 720 ha should be implemented for five years. INDRHI will work as a coordinator among various institutions relating to this plan, manage the whole plan and support the activities in the model area assigning some site coordinators.

Wildlife Conservation in Rincon Lagoon

101. In the Rincon Lagoon, covered by the national park of 47 km², several kinds of valuable wildlife species exist. Recently the fluctuation of water level and the lack of water are considered to affect the wildlife existence. The lagoon worked as a retarding basin for floodwater from the Yaque del Sur River. It is possible the water volume introduced from the river to the lagoon reduced after the construction of Sabana Yegua Dam. There is, however, no sufficient data to judge the impact to the wildlife species by the water level fluctuation. A long term monitoring of the fauna and flora is necessary to understand the relation between the environmental change and its impact to the wildlife.

The study will be divided into two stages: the first stage is set for generally understanding the condition of fauna and flora and for planning the further study made as a second stage; in the second stage, the study will be probably made every two months to monitor the condition of fauna and flora and to understand the relation between the water fluctuation and its impact on life in the lagoon. It will take 10 years. The Sub-secretariat of Natural Resources (SURENA) and National Direction of Parks (PARQUE) will be the main organizations to coordinate and manage the plan.

Initial Environment Examination (IEE)

102. For the proposed projects, an initial environmental examination (IEE) has been performed. At first, project features and conditions of each proposed project are identified. Secondly, each proposed project is examined from the natural environmental, social and economic social aspects. As a result, the Yaque del Sur Lower Reaches Irrigation and Drainage Project and Galvan Groundwater Irrigation Project should be examined in terms of soil salinization through the Environmental Impact Assessment (EIA). Also the Jose Joaquin Puello Dam Development Project should be examined in terms of disappearance of agricultural land and forest in the area of reservoir.

Action Plan

103. In the master plan, 27 projects have been formulated. One is for the agricultural development, 6 projects for agricultural support services, 1 project for overall water management in the Yaque del Sur River Basin, 9 projects for irrigation and drainage development including strengthening water users associations, 4 projects for rural infrastructure development, 2 projects for environmental conservation and 4 projects for water resources development. The master plan is formulated as a 10-year plan up to the year of 2010. These projects are co-related and should be executed in an efficient way through proper combination and appropriate scheduling.
104. For the project evaluation for these projects, benefit and cost are estimated as shown in Table 19. Benefits of agriculture and irrigation and drainage projects are estimated as the difference in farm profit from crops between the future with-project and without-project conditions. Farm gate prices of farm inputs and outputs in the Study area in 1998 were used in the evaluation. With respect to credit service and seed multiplication plans, internal rate of return is calculated for assessment. For the projects related to other agricultural support service, overall water management, rural infrastructure, environment and water resources, benefits are not calculated. Costs of these projects are estimated based in the market prices of 1998 in the Dominican Republic. The exchange rate used in the cost estimate was 14 Dominican Pesos = one US\$. Shadow wage rate and standard conversion factors for costs are not used for economic evaluation in this study. Under such condition, the agriculture and irrigation/drainage projects are economically evaluated by internal rate of return. Other projects are not economically evaluated. All projects are preliminarily assessed in view of environmental and social impacts. As a result, the implementation schedule of these projects in each sector is illustrated in Fig 21.

SELECTION OF HIGH PRIORITY AREA(S) AND HIGH PRIORITY PROJECT(S)

105. The Study area is characterized as the poorest areas in the country. Most of the people are engaged in agriculture and its related activities. With the exception of agriculture, there are no big potential resources to be developed such as minerals. Therefore, it is principally sound that the agricultural development in the Study area should be properly performed.
106. Selection of high priority area(s) for development in the Study area should be made for the most depressed areas considering the following: (1) Living standard of people, (2) Access to the social services and (3) Access to water resources. Availability of data and information on the level of municipality and rural sections are very limited and an accurate identification of the characteristics of areas on such levels could not be performed. Therefore, it is considered sound to select priority area(s) at the provincial level.

Factors for Selection and Evaluation

107. For selection of the high priority area, the features of each province will be assessed from the following 9 evaluation factors, namely, (1) total farm profit per farm household, (2) extension service ratio of potable water, (3) medical services, (4) illiteracy rate, (5) unemployment rate, (6) farm size, (7) rainfall, (8) ratio of irrigated area/arable land and (9) irrigation efficiency. It is designed for the evaluation of the features of province that the weighted points are given to each evaluation factor, that is further graded as follows:

Evaluation factor	Grade	Description	Point
1. Total annual farm profit/household: (Due to lack of data about farm household, we estimated farm income based on the profit irrigated farmers)			30
	Grade-1	Above 50,000 peso	10
	Grade-2	50,000 to 40,000	20
	Grade-3	Less than 40,000 peso	30
2. Extension service ratio of potable water: (comparison with service rate of national level, 67 %)			5
	Grade-1	Above 67%	2.5
	Grade-2	Less than 67%	5
3. Medical service: (comparison with rate of the number of doctors/1,000 people, 0.72 doctors/1000 people)			5
	Grade-1	Above 0.72	2.5
4. Illiterate rate: (comparison with illiterate rate of the national level, 21 %)			5
	Grade-1	Less than 21	2.5
5. Unemployment rate: (comparison with unemployment rate of the national level, 18 %)			7.5
	Grade-1	Less than 18%	3
6. Farm size: (we use farm size for the farmers in the existing irrigation systems due to shortage of data)			7.5
	Grade-1	Above 3 ha	3
7. Rainfall: (annual rainfall of 500 mm is the boundary of dry and semi-dry climate indicating possibility of crop selection, and/or rate of annual evapotranspiration/annual rainfall is 4)			15
	Grade-1	Above 500 mm	5
8. Rate of irrigated area/Arable land: (rate of irrigation area /arable land classified into 2, 3 and 4 classes in USDA classification)			15
	Grade-1	Above 60	5
	Grade-2	30-60	10
9. Present irrigation efficiency: (present irri. efficiency is set as efficiency for estimate of present irrigation water requirement for upland crops)			15
	Grade-1	Above 30 %	5
	Grade-2	Less than 30 %	10

108. Based on the selection criteria, the four provinces are evaluated as follows:

Evaluation factors	Azua province			San Juan province			Barahona province			Bahoruco province		
	figure	grade	weighted point	figure	grade	weighted point	figure	grade	weighted point	figure	grade	weighted point
(1) total annual farm profit per household (1000peso)	52.6	1	10	41.3	2	20	35	3	30	35	3	30
(2) extension service ratio of potable water (%)	61	2	5	44	2	5	69	1	2.5	53	2	5
(3) medical service (no. of doctor/1,000 people)	0.14	2	5	0.06	2	5	0.3	2	5	0.09	2	5
(4) illiterate rate (%)	36	2	5	35	2	5	28	2	5	36	2	5
(5) unemployment rate (%)	48	2	7.5	48	2	7.5	35	2	7.5	49	2	7.5
(6) farm size (ha)	1.73	2	7.5	3.48	1	3	1.7	2	7.5	1.7	2	7.5
(7) annual rainfall (mm/year)	660	1	5	930	1	5	460	2	15	470	2	15
(8) rate of irrigated area per arable land (%)	84	1	5	92	1	5	40	2	10	18	3	15
(9) present irrigation efficiency (%)	31-32	1	5	30-40	1	5	32-35	1	5	28	2	10
Total points			55.0			60.5			87.5			100.0

This table indicates that Bahoruco province has the highest scores of 100.0 points, followed by Barahona (87.5 points), San Juan (60.5 points) and Azua (55.0 points). Among provinces, the higher two provinces of Bahoruco and Barahona have been selected as high priority areas.

Selection of Project for the Feasibility Study

109. As mentioned in the basic development concept, development includes agriculture in the hilly and the flat area. The selected area (in Bahoruco and Barahona provinces) lies in the semi-arid zone with little rainfall, where most of the farmers are therefore engaged in the irrigated agriculture.

110. Since the most important crop in the selected area is plantain, the most important matter is to increase and stabilize its production for the stable farm management and improvement of farmers' lives. For that purpose, the limited water resources should be utilized effectively. Consequently, the feasibility study is carried out, proposing model

integrated rural development projects, of which main components are improvement of the existing irrigation system and establishment and strengthening of the water users' organization.

111. Agricultural land is extended along the Yaque del Sur River in the selected area. The land between Los Guiros and Santana headworks receives sufficient water and therefore the development for this area is not considered very urgent. The lower reaches of Santana headworks are the most serious area suffering from the chronic water shortage caused by the deteriorated facilities and suspension of the pump operation due to the continual brownout. On the other hand, the selected area is the most depressed area in terms of the living conditions of the villagers. Accordingly, the feasibility study is to be conducted for 'the part of the Yaque del sur Lower Reaches Irrigation and Drainage Project located in the downstream of the Santana headworks'. The objective area selected is about 6,000 ha. The area under the sugar corporation is however excluded from the area of the feasibility study.
112. Villarpando weir has difficulties in controlling water due to the structural disadvantage and deteriorated gates at present. Agricultural development in the selected area requires more precise discharge control at Villarpando, therefore the feasibility study will include the rehabilitation of the Villarpando headworks and water distribution program.

Conclusions and Recommendation

113. As a result of the Master Plan Study on the Agricultural Development in the Yaque der Sur River Basin Agricultural Development Project, the constraints of agricultural development are revealed as summarized below.
 - (i) The Study area is classified as semi-arid to arid area having scarce rainfall with large variation in occurrence and amount. Majority of annual rainfall is concentrated in several months in the rainy season and rainfall patterns are unstable. The river runoffs in the dry season reduce remarkably to small amounts.
 - (ii) In the Study Area, shifting cultivation has been practiced. It induced that many forest trees were cut down, vegetation in the basin remarkably got reduced, and soil erosion and soil degradation were caused. This further causes sediment problems in Savaneta and Sabana Yegua dams as well as in irrigation canals, and declined agricultural productivity of soils.
 - (iii) The existing irrigation facilities are superannuated, and diversion structures and other appurtenant structures are insufficient for ensuring proper water delivery. Besides, the water management system is not set up yet. This condition leads to inefficient water use, remarkably low irrigation use efficiency, and lowering of annual cropping intensity.
 - (iv) The crop production is decreasing due to degraded quality of seeds and seedlings, low agricultural inputs, improper water management and inadequate cultivation techniques, etc.
 - (v) Agricultural support services such as extension services, research, seed multiplication, agricultural information, agricultural credit, etc. are limited due to shortage of budget, well trained staff, agricultural equipment and tools.
 - (vi) The basic rural living infrastructures are insufficient.
114. It is confirmed that the following points are prerequisite for ensuring the successful agricultural development in the Project area.

- (i) To alter the shifting cultivation to sedentary agricultural cultivation, as well as to promote reforestation
- (ii) To introduce the low cost agricultural production techniques to enable to sustain soil fertility required for the upland development in rainfed area.
- (iii) To introduce the improved irrigation techniques consisting of use of high quality seeds and seedlings, adequate cultivation techniques, proper irrigation water management
- (iv) To set up the proper agricultural production infrastructures consisting of improvement of existing irrigation facilities, construction of irrigation facilities for night storage, change of pump irrigation systems into gravity irrigation systems, improvement and construction of inspection roads and diversion structures
- (v) To establish and strengthen the farmers water users associations responsible for O&M of irrigation facilities.
- (vi) To set up Yaque der sur Water Management Center responsible for river basin water management
- (vii) To construct rural and social infrastructures consisting of rural roads, rural water supply facilities, rural electrification, community center, etc.
- (viii) To improve and strengthen the agricultural support services consisting of practical technique research, training for capacity building to extension workers and leading farmers, preparation of land registration and land tenure shifting services required for credit service, establishment of model agricultural cooperative, network of market information system
- (ix) To set up institution for agricultural support services consisting of raising of agricultural techniques of extension workers, strengthening of CIAZA Agricultural Research Center, introduction of group credit, promotion of seed multiplication by CIAZA and private sector, strengthening of agricultural cooperatives, introduction of agricultural information system, etc.
- (x) To execute monitoring for the purpose of preservation of Rincon lake

115. As a result, twenty-seven (27) development programs have been formulated in the Master Plan Study on the Agricultural Development in Yaque der sur River Basin, which consists of agricultural development program, agricultural supporting services program, river basin water management program, irrigation development program inclusive of setting up of water users association, rural infrastructure improvement program, environmental preservation program and water resources development program.

116. With respect to living conditions of people and social set-up and water resource, most economically depressed areas were selected in the Study Area. Then in view of high economic efficiency, high model effect and a large number of beneficiary, the existing irrigation area having about 6,000 ha in the lower Yaque der sur river basin including improvement of Villarparando headworks was selected as the first stage development.

117. On the basis of the above-mentioned result, it is recommended to carry out the feasibility study on the existing irrigation area having about 6,000 ha in the lower Yaque del sur river basin coupled with the improvement of Villarparando headworks and its function.

PHASE – 2. FEASIBILITY STUDY ON THE AGRICULTURE DEVELOPMENT IN THE LOWER YAQUE DEL SUR

Present Conditions in the Project Area

118. Administratively, the Project Area is fully or partly under the jurisdiction of Barahona and Bahoruco provinces, 5 municipal districts, namely, Vicente Noble, El Peñon, Fundacion, Tamayo, and Uvilla, and 13 rural sections. The total population of the Project Area related to the administrative jurisdiction to the Project area was an estimated 68,000 in 1998. The total number of households is estimated at 15,800 out of which about 30% own farms.
119. Main social problems in the Project area are a high unemployment rate of 40% and a high illiteracy rate of 31%. Rural infrastructure has not been sufficiently developed due to population pressure, deterioration of facilities, damages by the hurricane George, and so on. Meanwhile, there are certain gaps in infrastructures among the villages in the Project area. Their major problems are observed in 1) drinking water supply, 2) farm roads, and 3) social infrastructure. Almost towns and villages in the Project area are included in multiple water supply systems (called "*acueducto multiple*") established by INAPA. There exist 6 multiple water supply systems in the Project area, which are however not satisfactory operated lately and their beneficiaries are facing both a shortage of water and poor quality because of system deterioration and pressure by the increasing village population. The Project area is traversed by CDE grid with transmission lines and most part of the area is energized, however they are facing shortage of power, low voltage, power cut-off due to the lack of total power generation and increasing loss caused by deterioration. For the pump irrigation beneficiaries, frequent power cut causes a serious shortage of the irrigation water. Most of the communities do not have garbage disposal system or sanitary system, which is identified as a major problem in the Project area.
120. Most farmers in the Project area own 20 *tarcas* (1.3ha) on an average. However, more than half of the lands owned by farmers are not registered. The average households consist of 5. Regarding education, 51.6% of farmers only achieved primary education. Farmers in the area produce plantain as the major food crop. Additionally, some farmers grow banana, cassava, corn, and processing tomato, papaya, melon and pepper. Livestock is produced in small scales mostly for family consumption. According to the sample farmers' survey, the farm budget of three categories of farmers: small farmer (below 1ha), medium farmer (1-2 ha) and large farmer (above 2ha) are summarized below. It may be concluded that the farmers remain at the subsistence level of living.

Item	Scale of Farm		
	Small	Medium	Large
Family size(person)	5	5	4
Range of farm size (ha)	Below 1	1-2	Above 2
Average farm size (ha)	0.61	1.3	4.3
Gross farm income (DR\$)	25,350	57,210	210,280
Non-farm income (DR\$)	11,500	11,500	0
Total gross income (DR\$)	36,850	68,710	210,280
Production cost (DR\$)	2,697	8,730	48,820
Living expense (DR\$)	34,320	56,950	111,750
Total outgrow (DR\$)	37,020	65,680	160,570
Surplus (DR\$)	-170	3,030	49,710
% of plantain income per gross farm income	80	80	80
% of non-farm income per total gross income	31	17	0
% of food expenditure per total living expense	56	47	38
Living expense per person per month (DR\$)	572	949	2,328
Surplus per person per month (DR\$)	-34	606	12,428

Land Classification

121. The soil study at semi-detail level was made by INDRH in 1982. That soil study included the entire area of the Project area. That soil study identified six (6) soil series and five soil associations. The land capability assessment was made. Eighty two percent of the lands is classified into II and III classes that are arable under normal farming cultivation. 5% is V and VI class that requires special farming treatment. Others are not classified lands.

Agricultural Climate and Hydrology

122. Climate of the Project area is grouped into the arid zone. The average annual rainfall is 660 mm, of which 70% falls in the rainy season. Mean monthly temperature and relative humidity are 26.3 °C and 74 %, respectively. There are no large variations in the average monthly temperature and relative humidity. Agroclimatically, a small amount of rainfall and its erratic distribution is the main serious constraints for agricultural development.

123. Eighty percent dependable discharges at Santana headworks and Villarpando vary from 11 to 20 m³/sec and 8 to 43 m³/sec, respectively as shown as follows :

Station	Period	Probability	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Villarpando (Villarpando headworks)	1960-1982	average	25.2	19.7	18.4	20.2	36.9	54.5	46.4	48.8	66.6	70.9	53.9	39.3
		80%	12.1	8.1	8.5	8.9	18.7	23	20.9	28.4	39.8	42.7	33	20.8
		90%	9.2	5.9	6.4	6.6	14.3	16.6	15.5	22.8	32.4	34.8	27.1	16.2
Conuquito (Santana headworks)	1984-1993	average	19	17.4	17.8	17.4	25.2	29.4	22.4	21.7	33.4	29	28.1	21.9
		80%	13.2	12.7	13	11.4	13	12.8	12.7	14.3	17.8	19.2	18	16.7
		90%	11.2	-	11.3	-	-	9.4	-	-	13.7	-	-	-

Due to lack of sufficient duration of river flow records, it is difficult to estimate the probable flood of longer return periods at Santana headworks. Judging from the design floods of other river basins in the country, an approximate specific discharge of 1.0 m³/sec/km² is assumed for 1 in 50 year recurrence level. Thus, 1 in 50 year flood at Santana headworks is estimated to be 4,600 m³/s. However, out of the catchment area of 4,578 km², some part is covered by the catchment of the dams (Sabaneta 464 km², Sabana Yegua 1,676 km²), and the floods should be reduced by the dam effect. One in 50-year flood from the residual catchment of the dams (2,460 km²) and the discharges from the service spillways (900 m³/sec for Sabaneta, 600 m³/sec for Sabana Yegua) amounts to about 4,000 m³/sec, which can be regarded as design flood at Santana headworks. The design flood discharge at Villarpando headworks (3,570 km²) is similarly estimated at about 3,000 m³/sec.

Present Conditions of Agriculture

124. Land use of the Project area is summarized below:

Land Use	Area(ha)	Ratio(%)
Irrigation Area	5,885	84.6
River & Lake	125	1.8
Shrub & Bush	190	2.7
House & Roads	760	10.9
Total	6,960	100

125. The main crop planted in the Project area is plantain, followed by banana, cassava, pepper, tomato, corn, melon, papaya, beans, and rice. An annual cropping intensity in the Project area is estimated at 0.75.

Crop	Average Planted Area (ha)	% of Total planted area	Crop	Average Planted Area (ha)	% of Total planted area
1) Plantain	3,430	77.4	8) Tomato	120	2.7
2) Sweet Potato	20	0.5	9) Melon	115	2.6
3) Pigeon pea	10	0.2	10) Papaya	110	2.5
4) Eggplant	15	0.3	11) Corn	70	1.6
5) Banana	170	3.8	12) Beans	50	1.1
6) Cassava	160	3.6	13) Rice	20	0.5
7) Pepper	140	3.2	TOTAL	4,430	100.0

126. Farming practices implemented by a large percent of the farmers in the Project area are so poor that it seriously causes low yields of crops. The crop yields are lower than that of the Yaque del Sur River Basin. The basic problems of farming practices are

- (i) Land preparation is not done in a timely manner and properly due to lack of mechanical power
- (ii) Most farmers use poor quality of seeds and seedlings.
- (iii) A level of application of farm inputs such as fertilizer and chemicals is low.
- (iv) Farm input are not always applied at right time and right volume and
- (v) Management on-farm water is poorly done and irrigation water is short.

The average yield by crops within the Project area is estimated as shown as follows :

Crop	Average Yield (ton/ha)	crop	Average Yield (ton/ha)
Plantain	18	Melon	30
Banana	24	Papaya	44
Cassava	6.5	Corn	1.5
Pepper	13	Beans	0.9
Tomato	21	Rice	2.2
Pigeon pea	1.5	Eggplant	15
Sweet potato	12		

127. The estimated crop production in the Project area is estimated as shown in table below.

Crop	Average Yield (ton/ha)	Average Planted Area (ha)	Total Annual Production (ton)
Plantain	18	3,430	61,740
Banana	24	170	4,080
Cassava	6.5	160	1,040
Pepper	13	140	1,820
Tomato	21	120	2,520
Melon	30	115	3,450
Papaya	44	110	4,840
Corn	1.5	70	105
Beans	0.9	50	45
Sweet potato	12	20	240
Eggplant	15	15	225
Pigeon pea	1.5	10	15
Rice	2.2	20	44

Marketing and Prices

128. The marketing system for agricultural commodities in the Project area is simple. Staple food crops of about 10% of plantain production, most production of cassava, corn, red beans, pepper and rice are consumed in the Project area. It is estimated that 90% of plantain production in the Project area are classified as class one and is transported to the Santo Domingo market or to export. Plantain growers sell their production directly to truckers and local middlemen at the farm gate. Farm gate prices of the main crops in the Project area show some fluctuation throughout the year. After Hurricane George, plantain prices skyrocketed. At the consumer level, plantain price went up from DR\$1.25/unit in August to DR\$6.50 in November 1998. The marketing margin between producer and consumer price ranges from 35 to 70% of the final price. For most cases,

the market with a heavy influence of local middlemen determines price mechanism. The marketing information system is practically not available in the Project area.

129. In the Project area farmers obtain fertilizers agrochemical inputs and seeds from the Center for Input Sales (CEVEMA). SEA provides machine services for land preparation through the Center for Machine Services (CESMA), however, the number of machinery is insufficient. The level of agroprocessing in the area is very low. The only processing plant within the Project area is a rice mill located in Canoa. The market infrastructure in the Project area is not adequate or non-existent. Only in Vicente Noble and Tamayo exist infrastructure. However, there are no facilities for the display and storage of products. Agricultural produces are displayed on the ground and there is not much concern for their quality and preservation.

Present Conditions of Irrigation and Drainage

130. The irrigation area is estimated at 5,885 ha net consisting of irrigation areas of Tamayo, Vicente Noble, Canoa-Palo Alto, and Peñon-Fundación.

Irrigation System	Area (ha)
Tamayo area	940
(Area served by small irrigation system)	(624)
(Area served by Santana system)	(316)
Vicente Noble area	1,393
Canoa- Palo Alto area	815
Peñon-fundacion area	2,737
Total	5,885

131. Tamayo irrigation system consists of 1) a system diverted from the Santana headworks, 2) a system diverted from Santana canal, and 3) systems diverting water from the Yaque del Sur River by free intakes. All these canals are totally earthen. They are deep especially in the upstream reaches and meander. The Vicente Noble area is served by one gravity irrigation canal system. The two main canals are provided with stone masonry lining in the most reaches and the laterals are of earthen-made. It is also characterized that all the canals are excessive deep and wide and meandering. Most of the canals in the Tamayo and Vicente Noble areas were buried with sediment or washed away by flooding caused by Hurricane George. The Canoa-Palo Alto area and Peñon-Fundación area are mostly served by pump irrigation canal systems. There are 29 pumping stations including two CEA pump stations and six IAD pumping stations along the Yaque del Sur River. All the pumps are of electric motor-driven type. Canals are mostly earth canal type and partly provided with concrete lining or stone masonry. Canal systems are not maintained well and more or less deteriorated especially for the gates.

132. The Villarparando headworks was largely damaged in the right side earthfill section by the flood of Hurricane George. INDRHI is planning to reconstruct the right side dike (755m in length) as emergency works. Out of three, only one manual intake gate is functioning. Sand flushing gates are not functioning, and due to this, waterway to and in front of the intake gate suffers from the sedimentation of sand and gravel. Such conditions allow silt, sand, and gravel easy access into YSURA head race.

133. Operation and Maintenance for the irrigation systems are of the responsibility of the Yaque del Sur Irrigation District except for the Tamayo area, which belongs to the I.D. Lago Enriqueillo. Total budget of the I.D. Yaque del Sur is about DR\$ 23 million. Personnel payroll accounts for about one-fourth and rehabilitation and maintenance of irrigation and drainage facilities account for nearly a half of the total budget. Though the unit rate of the water charge is set at a very low rate, only 25% of total registered users paid water charges in 1997. Its amount is less than 10% of total amount required

for O&M works. WUOs were founded in Peñon and Fundación areas in early 1980s. INDRHI newly started to guide farmers to make WUO. The works to organizing farmers, however, have been required to suspend.

134. The insufficient river water is caused by the absolute shortage of the river water resources or man-caused problems. The absolute shortage of the river water resources rarely occurs except the drought season of an extreme drought year. Most of the causes of the insufficient river water is of man-made, for example, improper diversion of water in Villarpando and Santana headworks, stop of pump operation due to the interruption of electric supply, and so on. Inefficient use of water in the fields is being caused by various aspects such as no care of water distribution due to shortage of operation staffs and no transportation means, difficulty of water distribution with no control structures, among others. Moreover, no basic data for operation and maintenance of irrigation systems such as ledgers of irrigation facilities and systems, a written rule on operation and maintenance in both the irrigation district offices and water user's organization, records of irrigation discharge at important delivery sites are available.

Agricultural Supporting Services

135. The South regional office of SEA in the Barahona zone containing 3 agricultural sub-zone and 23 agricultural areas is responsible for extension services in the Project area. The total number of extension workers who are not always trained is 23. In addition to SEA, the Agrarian Institute is providing some extension service to the Land Reform Beneficiaries. There is no schedule to visit farmers on a regular basis and field extension aids are insufficient. In January 1998, SEA provided motorcycles to all extension workers in the Project area. However provision of extension services to farmers is irregular and its activity is not poor. SEA has a training center in Barahona that has a total area of 15,050 m². However, the buildings need some refreshing. Also, there is a lack of furniture and teaching aids as well as a computerized system for training. The Barahona experimental station, located in Palo Alto, has about 300 tareas (18.8 hectares) where is operated by 2 researchers. It faces some problems with irrigation water availability due to deterioration of irrigation and drainage facilities.
136. Most of the financing of agricultural business comes from the Agricultural Bank, and local moneylenders. In addition to those, commercial banks, agroprocessing firms and some NGOs lend funds. One of the main constraints found in the Study area is the inability to access formal credit. The main constraints have been identified as lack of definitive land title, high interest rate, high transaction costs to process individual loan request and complex procedures for obtaining loans. The total number of bank loans, values and coverage area that the Agricultural Bank provided farmers in the Project area in 1997 was estimated to be 310, 9.5 million DR\$ and 870 ha. The Agricultural Bank loans for crops totaled DR\$ 9.5 millions in 1997 (about 17% of total credit demand). About 70% of the total amount of the loans were allocated to the plantain cultivation. It is estimated in the Project area that 7% of the farmers received the loans of 2,100 DR\$ on an average and also the loans covered 15% of the Project area.
137. There is no seed multiplication system in the Project area. Most seeds and seedlings of plantain, cassava and banana are produced individually by farmers. CEVEMA are responsible for the distribution of seed material for the request of farmers.
138. In the Project area there are 72 farmer's associations. About 70% of the total farmer's associations have less than 50 members. Most association becomes a body to receive agricultural credits. Based on the Rapid Rural Appraisal, most associations are institutionally weak and their activities such as cooperative marketing of their products

and procurement of farm inputs have not been performed yet. Most associations do not own office space. Though most farmers of the associations recognize that their benefits for farmers to participate the association are the ability to get better access to credit, prices and market, farmers do not use this mechanism to sale their crops.

THE AGRICULTURAL DEVELOPMENT FOR THE PROJECT AREA

Development Constraints

139. The Project area is the least developed area in the Yaque del Sur River Basin. The annual rainfall is small, averaging 660mm. Seventy percent of the annual rainfall is concentrated during the rainy season. Under such situation, agriculture in the Project area cannot be performed without irrigation water. Main constraints on agricultural development in the Project area are: (1) the existing irrigation facilities are deteriorated and their operation/maintenance is not properly functioning, so an overall irrigation efficiency in the Project area is very low, which brings about great loss of irrigation water within limited water sources. (2) Villarpando headworks, which delivers Yaque del Sur River water into Azua irrigation district area and Yaque del Sur /Lago-Enriquillo irrigation district area, has its deterioration, malfunction in its structure and its improper operation, so waters do not properly allocate to the Project area. (3) Improved irrigation farming can not be introduced due to the present poor irrigation facilities. (4) Due to poor access to credit services for introduction of improved irrigation farming technology, only 7% of the total farmers in the Project area received loans from the agricultural bank. (5) Agricultural research and extension services are poor. (6) Farmgate price is lower as it is because marketing margin from producers to consumers is bigger. (7) The average farm size in the Project area is small, being 1.3 ha.
140. Under such conditions, yield of plantain, the main crop in the Project area, is as low as 18 tons/ha and an annual cropping intensity amounts to only 75% in spite that the Project area is categorized into the irrigated lands. As a result, the farmers in the Project area, most of which are plantain growers, have low agricultural incomes and few surplus in their economy. Engel's coefficient is high. It may be concluded that the farmers remain at the subsistence level of living. Furthermore, environmental conditions around the farmers are poor due to shortage of rural infrastructure. It is necessary to deal with these constraints and problems in order to implement agricultural development efficiently.

Basic Development Concept

141. The overall objectives of the Project are (1) stabilization of the farmer's economic situation by increasing farm income, (2) improvement of life quality of the farmers, and (3) creation of job opportunity for local people and improvement social welfare. The basic development concept of the agricultural development in the Project area is:
- (i) Increasing crop yields by the introduction of improved irrigation farming technology
 - (ii) Increasing annual cropping intensity by increasing an overall irrigation efficiency and effective use of river water which is made by improvement of the existing irrigation systems, setting up and strengthening water user's organization create, and strengthening overall water management in the Yaque del Sur River Basin.
 - (iii) Strengthening the support services for agricultural development
 - (iv) Improvement of rural infrastructure
142. The crop productivity can be enhanced through improved irrigation farming technologies such as use of high quality seeds and seedling, appropriate application of fertilizers and

chemicals at the right time and in volume, proper on-farm irrigation practices, and so on. Especially, for plantain that grows on about 80% of the lands in the Project area, replanting at an interval of 5 years will be performed to keep a level of 24 tons/ha of the target yield. It is planned that an annual cropping intensity is targeted at 113% with project condition from 75% in the present condition.

143. For obtaining this purpose, the following measures will be taken: (i) Santana headworks and the existing irrigation facilities will be improved and new construction of main canals from Santana headworks that unify the existing small free intakes, night storage ponds, O&M roads, and so on, will be made, (ii) Water user's organization with three tier will be formulated and O&M for irrigation system by water user's organization will be strengthened, (iii) To properly allocate river water to Azua irrigation district area and Yaque del Sur/Lago-Enriquillo irrigation districts (including the Project area), Villarpando headworks will be improved, (iv) For effective use of river water including released water from Sabana Yequa Dam, the Yaque del Sur Water Management Center, which will monitor and evaluate water budget at relevant control points, operate and maintain facilities directly and indirectly according to the results of evaluation and coordinate water distribution through a year at real time, is made.
144. In order to reinforce agricultural services for agricultural development in the Project area, the following matters will be made: (i) With respect to research services, a research program of adaptive and applied on-farm research for plantain will be carried out on sublet basis of private sectors. (ii) Extension service in the Project area will be given not to an individual farmer but to nucleus of water users. In order to strengthen extension services, training programs are carried out to extension workers along with leaders of nucleus of water users to develop their capacity. (iii) Most serious constraints of access to credit services in the Project area are that considerable farmers have no definite land title and can not get loans. In the Project area, land ledger will be made by the cadastral survey and land registered will be made for provision of a base to farmers to get loans. (iv) It is considered necessary as the first step that agricultural cooperative, which are able to provide services to farmers, should be strengthened as a model agricultural cooperative. A market information system, which will provide information timely with farmers to make sound economic decision, is introduced.
145. With respect to reinforcement of rural infrastructure in the Project area, improvement of the existing rural structure and planning, which the related Ministries manage, will be not dealt with in the Project. As a result, rural water supply systems and multipurpose community centers will be provided to improve quality of life of farmers.
146. Floods that brought by Hurricane George seriously damaged Tamayo town. In line with protection of the town from flood damage and river margin, the green belt along the riverbank will be constructed. Monitoring will be done to collect basic data in long terms of wildlife and its habitat and also on water user for agricultural purposes.
147. Development plans are formulated on six sectors: (1) agriculture, (2) agricultural support service, (3) overall water management (4) irrigation and water user (5) rural infrastructure and (6) environmental conservation to achieve these purposes.

AGRICULTURAL FARMING IMPROVEMENT PLAN

Land Use Plan

148. As the irrigation development plan is formulated to improve and/or rehabilitate the existing irrigation area of 5,885 ha, new irrigation areas will not be created. Then, future land use of the Project area will not be changed. The irrigation project will provide sufficient irrigation water to increase crop production by increasing crop yield and

cropping intensity through implementation of irrigation systems. The annual cropping intensity will be expected to increase from 0.75 at present to 1.13 after the Project.

Proposed Cropping Pattern and Farming Practices

149. It is not proposed to introduce new crops into the Project area, taking into account the farmers' experiences, farmers' preference to the crops, marketability and profitability of present crops, soil suitability for the crops, and local consumption as staple foods. The crops to be planted with Project condition will be same as those under present condition, such as plantain, banana, cassava, pepper, tomato, melon, papaya, sweet potato, eggplant, pigeon pea, corn, bean, and rice. For formulating cropping pattern, special emphasis is given to the following points:

- (i) Planting period of tomato for processing is fixed during cool season from beginning of October through December in order to minimize the damages due to pests and diseases, especially 'white fly'.
- (ii) Planting period of red bean, pepper, eggplant and melon is also fixed during cool season from beginning of November through March in order to minimize the damages due to pests and diseases.
- (iii) Repeating cultivation of tomato for processing is prohibited in order to prevent from the damages due to the repeating.
- (iv) 80 days improved variety of pigeon pea is introduced instead of present 270 days variety in order to minimize the irrigation water requirement and to effectively utilize the rainfall.
- (v) In order to obtain the highest yield of plantain and banana, replanting will be performed every 5 years for plantain and every 2 years for banana. Inter-cropping will be introduced at the replanting time.

The areas proposed to be planted by each crop with Project conditions is decided by augmenting the area of each existing crop proportionally to the percentage to be occupied at present by each crop, except rice and banana. Proposed planting area by each crop in the Project is shown below:

Crop	Proposed Area (ha)	Proportional Distribution (%)
1 Plantain	4,550	77.3
2 Tomato	250	4.3
3 Sweet potato	450	7.6
4 Melon 1	100	1.7
Melon 2	100	1.7
5 Pepper	190	3.3
6 Papaya	240	4.1
7 Cassava	220	3.7
8 Banana	170	2.9
9 Pigeon pea	140	2.4
10 Corn	100	1.7
11 Bean	60	1.0
12 Eggplant	30	0.5
13 Rice 1	20	0.3
Rice 2	20	0.3
TOTAL	6,640	113

150. Proper farming practices are essential for realizing the full agricultural potential in the Project area. It is necessary to carry out farming using an appropriate farming practice along with the development and strengthening of institutional support. The most important factors about farming practices to be introduced into the Project area will be focussed on (i) use of good quality seedlings and seeds, (ii) an appropriate dosage and time of application of fertilizer and chemicals (for control of insects and nematodes) and (iii) adequate on-farm water management. The proposed farming practices were

formulated by referring to the farming guideline prepared by SEA, data from the advanced farmers in the Project area and data from other information.

Agricultural Productions and Crop Budgets

151. The target yield of crops under with Project condition is set considering potential yields of recommended varieties and yields obtained by some advanced farmers within the Project area. The anticipated yield and total production of crops with Project condition is as follows:

Crop	Anticipated Yield (ton/ha)	Harvested Area (ha)	Anticipated Production (ton)
1 Plantain	24	4,550	109,200
2 Tomato	30	890	26,700
3 Sweet potato	17	550	9,350
4 Melon	40	410	16,400
5 Pepper	18	315	5,670
6 Papaya	52	240	12,480
7 Cassava	12	220	2,640
8 Banana	36	170	6,120
9 Pigeon pea	3	140	420
10 Corn	2.8	100	280
11 Bean	1.5	60	90
12 Eggplant	20	120	2,400
13 Rice	4.5	40	180

152. The total annual requirement of farming inputs in the Project area at the full development stage of the Project is estimated at 1,200 tons of N, 900 tons of P, 1,400 tons of K, pesticides of 120,000 liter (kg), and labor requirement of 850,000 man-days,

153. The farm labor balance for an average farm size farmer of 1.3 ha and for the whole Project area was analyzed to clarify whether a serious labor shortage occurs and bring about big problems on farming with Project condition. Annual total labor requirement for the whole Project area is estimated at 850,000 man-days, while annual total available farm household labor is one million man-days. The peak labor requirement is in January. Monthly labor requirement in January for 1.3-ha farmer is calculated at 24 man-days, while available farm household labor per month is 50 man-days. As a result, shortage of labor will not occur with Project condition in both farmers and the whole Project area.

154. The profitability of crops with and without Project conditions is analyzed by preparing a crop budget and is summarized below:

Kind of crop	With project condition			Without project condition		
	Gross income	Production cost	Primary profit	Gross income	Production cost	Primary profit
plantain	88,028	21,864	66,164	67,140	16,460	50,680
tomato	97,350	25,570	71,780	74,640	22,580	52,060
sweet potato	69,480	16,390	53,090	49,040	14,090	34,950
cassava	58,340	18,810	39,530	31,600	16,580	15,020
rice	39,600	29,820	9,780	19,360	22,720	-3,360
bean	21,750	16,360	5,390	13,050	12,430	620
pigeon pea	27,280	9,640	17,640	13,640	9,570	4,070
eggplant	93,100	21,230	71,870	69,830	18,470	51,360
corn	12,240	10,260	1,980	7,870	7,030	840
melon	105,600	36,870	68,730	79,200	31,010	48,190
pepper	108,900	25,550	83,350	78,650	21,580	57,070
papaya	156,900	26,280	130,620	131,795	23,485	108,310
banana	40,724	22,284	18,440	27,770	16,660	11,110

Plan for Strengthening Agricultural Support Services

155. A research program of adaptive and applied on-farm research would be implemented mainly for plantain banana, of which the topics to be emphasized would be (i) integrated pest management, (ii) feasibility of new crops in the Project area, and (iii) on-farm water

management issues. This research work will be carried out in agricultural experimental station at Palo Alto under SEA by sublet contract to universities and private firms. For this purpose, rehabilitation of the irrigation systems and the building is required.

156. It is planned that extension service in the Project would be given not to individual farmers but to groups as nucleus of water users. The objective nucleus of the water users are 200. It is planned that one extension worker covers 10 nucleus of water users. Therefore, the Project will demand 20 extension workers. In order to strengthen extension service, training programs will be carried out to extension workers along with leaders of nucleus of water users. The objective number for training is 20 extension workers and 200 leaders of nucleus of water users. This training would be carried out during the two years in SEA training center in Barahona. It would also ask for equipment and furniture.
157. Demonstration plots with 0.2 ha each would be set up at 10-selected farmer's plots to help on the transfer of technology by the extension workers and dissemination of proposed farming practices to farmers in the Project area.
158. It is proposed that a cadastral survey, which would help in the clarification and provision of definite land title to most of the farmers in the Project area, shall be conducted. The cadastral survey will be made by sub-let contract with private firms. The survey will be done for about 7,000 ha including net irrigation areas during 5 years. Cadastral maps that show an area of each land plots, land use item, name of landowner and tenure status of each land plots will be prepared on a scale of 1/1,000.
159. It is considered necessary as the first step that agricultural cooperative, which are able to provide services farmers should be strengthened as a model agricultural cooperative. Since most of the farmers in the Project area are plantain growers, among the present about 20 agricultural cooperatives in the Project area, "the plantain grower association of Vicente Noble" would be selected as a pioneer cooperative. Its improvement is planned being paid on (i) increasing of the members of this association (target: 100 members), from 16 members at present (ii) improvement of capability of board members (president, vice president, treasurer and secretary), (iii) strengthening market development and (iv) strengthening procurement power of farm inputs. The Project component consists of (i) institutional and managerial guidance and training, (ii) provision of start up funding and (iii) procurement of truck, scales, computers and office facilities and (iv) construction of small storehouse for farm inputs.
160. For the Project area it is proposed that a Market Information System, which would provide farmers with timely information to make sound economic decision be introduced. The Dominican Agribusiness Council (JAD) could handle the headquarters of the Market Information System in Santo Domingo. Under JAD, it is planned that new market information centers at farmers' associations in Bahoruco and Barahona cities will be set up. In Bahoruco, the branch will be instituted in the above proposed model agricultural cooperative, "the plantain grower association of Vicente Noble". In terms of market information, it would provide weekly information on local prices for agricultural products of plantain and inputs, and potential buyers of their product.

Overall Water Management Plan

161. The overall water management in the Project follows the plan formulated in the Master Plan that is explained from items 57 to 64. Villarpando headworks which function to deliver river water to Azua irrigation district areas and Yaque del Sur/Lago-Enriquillo irrigation district areas including the Project areas is the key point for the water management of the Yaque del Sur River Basin. Thus, the Yaque del Sur Water Management Center Project was planned.

162. Following telemetering and telecontrolling stations will be established.

- (i) Yaque del Sur Water Management Center at Villarpando,
- (ii) Villarpando headworks control station,
- (iii) Sabana Yegua Dam station,
- (iv) Sabaneta Dam station,
- (v) Sabana Alta hydrometric and raingauge station,
- (vi) Los Guiros hydrometric station,
- (vii) Santana headworks control station,
- (viii) Rincon Lagoon hydrometric and water quality monitoring station
- (ix) Palo Alto hydrometric and raingauge station, and
- (x) San Juan hydrometric station

163. The management level is divided into three levels, namely: Inter-basin water management (LEVEL-1), Basin water management (LEVEL-2), and Irrigation area water management (LEVEL-3). The central office or administrative functions for the overall water management would be established at Yaque del Sur Water Management Center. The Center would be independent not only from Irrigation Districts of INDRHI but also from local administrations. The activities and functions are discussed and supervised by a committee which consists of water-related institutions such as INDRHI, INAPA, CDE, water users' organizations (WUO). The existing organizations for the operation of Sabana Yegua Dam and Sabaneta Dam are the Council on the Control of Dam Basins and the Committee for the Operation of Dam Basins. The Yaque del Sur Water Management Center will take a part of the roles of the said Committee on the management of the two dams. Santana Field Office will be situated on Level 2, and control the waters to several irrigation areas such as the sugarcane farm of CEA, the Yaque del Sur Lower Reach Irrigation and Drainage Project, and other small irrigation schemes in Yaque del Sur and Lago Enliquillo Irrigation Districts.

164. The Yaque del Sur Water Management Center will be located at Canoa near Villarpando headworks. All the data and information will be sent and compiled to the Center, and the instructions on the operations of Sabaneta Dam, Sabana Yegua Dam and Villarpando headworks will be discussed and issued by the Center. A senior engineer of INDRHI will be assigned as the representative of the Center and will stay for ordinary working hours and emergency periods. At least one engineer will stay at the Center all the time.

165. Santana Field Office of the Yaque del Sur Water Management Center will be built at Santana headworks on the right bank of the river. The functions of the field office are to maintain and monitor the telemetric stations and warning stations below Quita Coraza, operate the Santana headworks and the Main Canal according to the water management authorities such as Irrigation Districts and/or the water users' organizations, which will be established in the future.

166. Yaque del Sur Water Management Center Project consists of i) telemetering facilities, ii) Water Management Center at Villarpando, iii) Santana Branch Office, iv) civil works for installing the telemeter facilities, and iv) Training for staffs for the water management.