8.6 Rural Infrastructure Plan

8.6.1 Basic Concept

Rural infrastructure improvement is on-going by the concerned organizations with their own middle / short term program and satisfies the minimum required provision level. Rural infrastructure plans are formulated based on the following basic concepts:

(1) Improvement target is set up to catch up with the national averaged level

(2) Gaps among the villages in the Project area are to be minimized

(3) The improvement of rural infrastructure should be integrated with the irrigation development within this Project

It is however noted that rehabilitation for the existing systems and present development program under the respective organizations would be excluded from this present study. Electrification with CDE system, water supply system with existing INAPA aqueduct, education and health care services are thus excluded from this Project. The present study therefore includes 1) construction of rural water supply facilities in the area not covered by the existing INAPA system, and 2) construction of community centers linked with the proposed strengthening plan of the water users' organization.

8.6.2 Rural Water Supply Plan

Though the INAPA long term plan shows a development plan including a wide water supply project, of which the source will the Yaque del Sur River, and extension of the existing systems, they are not realistic yet. A water supply plan is formulated in three villages namely 1) Bombita, 2) Los Robres, and 3) Altagracia, which are located out of the existing INAPA system and hence facing the serious shortage of drinking water supply. These villages are mostly of settlements of sugarcane labors and there are remarkable gap compared to the villages of irrigated farmers.

Bombita and Altagracia villages are located along the proposed main canal, therefore economical water supply systems can be designed with its available water source, while Los Robres system will depend on the Yaque del Sur River as its water source. Proposed rural water supply systems for these villages are summarized as follows.

Village	Bombita	Los Robres	Altagracia
Estimated Population(1998)	1,100	350	850
Growing Ratio	3.0%	1.3%	3.0%
Designed Beneficiary(2018)	2,000	500	1,600
Water Source	Proposed Main Canal	Proposed Main Canal	Yaque del Sur River

Each proposed water supply system consists of i) pump, ii) settling pond and filtration gallery, iii) chlorinating, iv) elevated water tank, and v) gravity distribution system with PVC pipe line. For the Bombita system and the Altagracia system, water will be pumped up at intake facilities on the night storage ponds which are designed between proposed main canal and lateral canals, and through settling pond, filtration gallery, and chlorination plant, and it will be discharged into the elevated water tank in order to be distributed to each house. For the Los Robres system, water will be pumped up from the Yaque del Sur River and be distributed through the same way as the other systems

The target year of the proposed systems is set at 2018 following the INAPA standard and designed to serve drinking water to each house. Following the INAPA design criteria and referring existing systems, the proposed systems are designed as described below. Hydraulic design of pipeline system is based on the Hazen-Williams formula and conveyance loss is estimated at 30%. The design was made based on the existing 1/5,000 topographic map.

Village	Bombita	Los Robres	Altagracia
Designed beneficiary	2,000	500	1,600
Beneficiaries per faucet	4.3	4.3	4.3
Averaged daily water requirement	125 lit/day	125 lit/day	125 lit/day
Max. daily water requirement	380 m^3/day	95 m^3/day	304 m^3/day
Intake pump, design discharge	260 lit/min	66 lit/min	210 lit/min
head	2.4 m	7.4 m	6.1 m
Discharge pump, design discharge	260 lit/min	66 lit/min	210 lit/min
head	14.1 m	19.4 m	13.1 m
Elevated water tank, capacity	200 m^3	48 m^3	150 m^3
Distribution pipe	ϕ4", ϕ2"	ϕ2"	ϕ4", ϕ2"

Proposed water supply system is summarized in Table 29 and Figure 42.

8.6.3 Community Center Plan

The community center is designed as a multipurpose hall with two functions of 1) office of the water users' organization (WUO), and 2) village level communication center. Location of these centers is allocated based on the development plan for the proposed water users organization as described in section 8.5.5. Since the main office of WUO will be established in Vicente Noble, office of the association of main canal in Fundación, and office of pump system in El Peñon, these three villages are selected for the construction of the community centers.

The proposed communication center consists of 1) office(s) for board members and stationed staff, 2) meeting room, 3) main hall, and 4) other rooms. Floor area will be 540 m^2 for type-A (Vicente Noble) and 420 m^2 for type-B (Fundación and El Peñon). Their floor plans are shown on Figure 43.

8.7 Consideration on Flood Mitigation

8.7.1 Capacity of the Yaque del Sur River

The river on the upstream of Santana headworks has about a one-kilometer-wide river course with meandering lower river bed of about 50 m wide, while the remaining sections are regarded as higher river beds. The total capacity of the river on the upstream of Santana is estimated at 20,000 m^3/sec or more.

At Santana headworks, the river starts meandering according to changes of the topography. Depression between Tamayo and Vicente Noble is considered as a flood plain of the river, and several traces of previous river courses remain. From Canoa to the downstream reach, there exist few mountains or hills along the river, and all the flat area is regarded as a flood plain. Thus the river capacity in this stretch is estimated by the lower river course, i.e., existing river course.

The results of the non-uniform flow analysis, which was conducted using the river survey results, concluded that the capacity of the Yaque del Sur River on the lower reach from Canoa to the sea ranges from 100 m^3/s to 200 m^3/s. From this, it is very clear that the capacity of the river sections on the downstream of Canoa to the Carribean Sea is more or less 100 m^3/sec. It should be noted that the flood flow of 1 in 50 years, which is estimated at about 4,000 m^3/sec almost overflows before Canoa. The river course in the lower basin is illustrated in Figure 22.

8.7.2 Flood Warning System

After the disastrous experience of Hurricane George, a flood/discharge warning system along the river is proposed. There are a number of flood mitigation measures to reduce or retard the flood runoff, but it is considered more important to fix the sense of "self-protection" in the people's minds to evacuate themselves quickly from the floods or other disasters. In this aspect, development of flood warning system will be a great help to establish a regional protection system against natural disasters.

The system will be developed by stage-wise and priority approaches for the high-flood-risk areas, such as densely populated areas, downstream of the dams, villages adjacent to the river course without proper access, etc. The flood warning system will utilize a telemetering system with control stations at the dams, warning stations, repeater stations, water level stations, warning vehicles, radio communication systems, etc.

8.7.3 Other Measures

During the flood periods, the river water overflows from the river course on the downstream stretch of the Yaque del Sur River. In order to improve such conditions, the following works are considered possible alternatives for flood mitigation in the lower basin. However, it is necessary to carry out another master plan study on flood mitigation to determine how to treat the flood waters. The design floods by return period will be distributed and discharged to proposed destinations, such as Rincon Lagoon, floodways, and the downstream river course, according to the mitigation plan.

(1) Flood Protection Dike at Tamayo

Tamayo is located in front of the flow direction of the Yaque del Sur River on the downstream of Santana headworks. The previous flood protection dike on the right bank was almost flushed away by the flood by Georges. The flood waters over the dike flowed into Tamayo, stagnated and brought huge amount of sediments in the city.

The previous dike was located very near the river course on the right bank without sufficient height and strength to control the flood. Taking into the proposed magnitude of floods (1 in 50 or 100 years), it is recommended to reconstruct the flood dike closer to Tamayo. The dike will be constructed on the right bank along the line which lies 70 to 80 % of the river width during Georges. Some structures or vegetation will also be proposed in front of the dike to control the force of floods to protect the dike itself.

(2) Canoa Floodway

During the flood period of the hurricane, certain part of the flood waters overflowed to the natural levee on the left bank at Canoa, flushed away the national highway between the two road bridges and flowed into the Caribbean Sea. This phenomenon has rarely happened before. Normally, a part of flood waters flows into Rincon Lagoon from Mena through Caño Trujillo – Dren Los Tomates. During the hurricane, the capacity of the drain was not sufficient to reduce the river water level, and the remaining waters overflowed the left bank at Canoa. The flood waters also flowed southward to Jaquimeyes which is sandwiched between the national highway and railway for CEA, and stagnated there.

The two road bridges at Canoa have no piers but only box culverts, of which capacity seems far insufficient to drain the flood waters. It is recommended to replace the two bridges with one bridge which has sufficient capacity to accommodate the proposed flood waters. A floodway from the bridge to the sea should also be considered to discharge the proposed flood properly. The capacity of the floodway should be discussed integratedly with other flood control measures or strategies for the whole lower river basin from Santana headworks to the confluence. Further study on the floodway with protection dikes is recommended in the future.

(3) Rincon Lagoon

The water level of Rincon Lagoon rose up to the full capacity from flood waters by Georges. As the flood water entered from northeast (Caño Trujillo-Dren Tomates), the Lagoon expanded to the north of El Peñon. The water of the Lagoon flowed to Neiba through Cristobal Canal from the west end of the Lagoon, and also overflowed easterly across the main road near Cabral. The waters flowed into the Yaque del Sur River to the east.

The water level of Rincon Lagoon had increased by 3 m by George, and increased volume is estimated at about 150 MCM. Thus, certain flood control effect is expected at Rincon Lagoon. Locations of the flood protection dike at Tamayo, the Canoa floodway and Caño Trujillo – Dren Tomates are shown in Figure 44.

8.8 Plan of Environmental Conservation

8.8.1 Green Belt Formation for Waterfront Conservation

The objectives of this project are: in case of floods, to reduce the force of water flash from the river, and as a consequence, to diminish the damage by flood in Tamayo town; to protect the river margin which is sometimes affected by water erosion; and to contribute a place of recreation for the town people of Tamayo and Vicente Noble. The green belt is formed in the right bank along the river as shown in Figure 45. It is around 1.2 kms long. A small recreation area is also established at the right bank near the bridge which is a very accessible place from both Tamayo and Vicente Noble.

Selected plant to form up the green belt is mainly bamboo (Bambusa bambus). The bamboo seedlings are supplied from the nursery of INDRHY at Barahona. Concerning the planting pattern, the spacing between bamboo is 3 m. The green belt consists of 9

lines, and the belt is about 21m wide. In a small recreation area of about 3000m^2 large, shade trees, such as Nin (Azadirachta indica), Roble (Catalpa longissima) and Caoba (Cedrela odorata) are randomly planted. The seedlings are provided from the nursery of the National Direction of Forestry (FORESTA) in Barahona or Cabral.

Since there is no steep and rocky area in the Project area, land preparation for planting involves just weeding. To plant a bamboo, first a hole with 30 cm depth is dug. A seedling is put there, and then the hole is filled up by soil. After that, water is added and about 5 oz. (140g) of fertilizer is put around the seedling. The shade trees to be planted are plants of 3 to 5 years old. To plant the trees, a hole with 50 cm depth is dug. After the planting, about 5 oz. of fertilizer is provided to each tree.

Concerning facilities required, a maintenance road along the green belt is constructed. The road is also used for taking a walk by local people. Some benches for local people to take a rest are collocated under shade trees in the recreation area and at some rest points along the maintenance road. Some steps to go down to or up from the dry riverbed are collocated.

The project is implemented by the Office of Watershed Management, INDRHY, with assistants from National Direction of Forestry. The project period, from the preparatory study up to planting, is about 5 months.

8.8.2 Environmental Monitoring Program in Rincon Lagoon

The objectives of this project are: to collect basic long term data on wildlife and its habitat, and also on water use for agricultural purpose; and on the basis of the monitoring result, to recommend the better water management of the lagoon, taking account of the importance of water for both agriculture and wildlife.

The total study period is 10 years. In the first half of the first year, a study to understand the general condition of the wildlife and water condition of the lagoon is conducted (General Study). After the study, from the second half of the first year until the tenth year, periodical studies focusing on some bio-indicator are carried out every two months (Periodical Study). In the 5th year and the 10th year, the studies with same content of the General Study are conducted. Since these studies substitute the periodical study, the periodical studies are finally carried out 55 times.

The object area of the general study is the whole area of the lagoon. The items of the study are: description of species of fauna and flora and their quantity; drawing of vegetation map; condition of ecosystem; measurement of water level and topography of the bottom of lagoon; measurement of inflow and outflow of water; and water quality of the lagoon (temperature, pH, COD, DO, NH4-N, NO3-N, total phosphate, number of colon bacillus, EC).

Considering the result of the general study, the planning of the periodical study, concerning the selection of the focused areas and the livings as bio-indicators, items of water quality analysis, and the detailed study method, is made. The periodical study is conducted to monitor the condition of wildlife and water, and to understand the relation between the water fluctuation and its impact on wildlife in the lagoon.

The field study concerning fauna and flora of general study as well as the periodical study is conducted by academic researchers from the SURENA of the Ministry of Agriculture, the Botanical Garden, universities and NGOs. The field survey concerning on the water condition is conducted by consultants. To manage this project, a committee consisting of representatives from relevant organizations is formed. Periodical meetings to understand the study progress and to coordinate monitoring plan are held by the committee members and survey staff. In each meeting, findings from the field and result of analysis are presented and discussed.

In the final stage when all monitoring study is finished, on the basis of the monitoring result, the better water management of the lagoon, taking account of importance of water for both agriculture and wildlife, is recommended. Water introduction from Yaque del Sur River to the lagoon and the lagoon's water use for agricultural purpose may be topics of the recommendations.

Concerning organization to carry out this project, the Sub-secretariat of Natural Resources (SURENA) and National Direction of Parks (PARQUE) are the main bodies. The committee is formed, which consists of representatives from SURENA, PARQUE, and INDRHY, and academic advisors from the Botanical Garden, universities and NGOs.

8.9 Plan of Operation and Maintenance

8.9.1 Overall Water Management

In order to maintain the functions of the facilities, operation and maintenance works are indispensable. In particular, the equipment and facilities for the telemetry, flood/discharge warning, and voice communication facilities, are mostly imported and require intensive training and meticulous maintenance. The inspection works are conducted in three forms as follows;

(1) daily inspection : minimum maintenance for daily operation

(2) periodical inspection : periodical (monthly) check-up of equipment from outside

(3) detailed inspection : checking of accuracy of measurement, function by suspending the operation; check the inside of the equipment, repair, changing of parts, adjustment, cleaning, etc; twice a year

An inspection manual will be prepared consisting of inspection items by equipment, methods, procedure, and check sheets for respective inspection form. As for periodical maintenance and detailed inspections, an inspection schedule chart should be prepared for the implementation.

Inspection records on the structure and functions are very important for the following improvement and replacement. They should be kept in the Center indefinitely. The daily inspection should be done at the beginning of shifts of operators. Some part of the periodical and detail inspections will be done by specialists on the system. It is recommended to make a contract for the detail inspection with the manufacturers concerned.

8.9.2 Irrigation and Drainage

(1) Operation

The operation will start from the estimation of the irrigation water demands. Based on the water demands and the availability of water resources, an irrigation schedule will be contemplated. Then the irrigation system from the head to the field level is operated in accordance with the irrigation schedule.

(a) Preparation of Seasonal Irrigation Schedule

As the preparation process of seasonal irrigation schedule proposed in the Master Plan study is rather complicated, a more simple procedure for the preparation of the irrigation schedule is proposed as follows.

(i) Estimate of irrigation water requirements : Each of the Irrigation District Offices or the irrigation engineer of WUO estimates the irrigation water requirements at the sub-committees level based on typical cropping patterns prepared in accordance with the last patterns and sums them up to the Santana intake level.

(ii) Water Balance : The Center evaluates the irrigation water demands through the water balance study between the demands and estimated available amount of water.

(iii) Irrigation Schedule : Then, if the irrigation water demands are expected to be smaller than the available water resources, the irrigation engineer will prepare an irrigation schedule to meet the estimated irrigation water demands. If the irrigation water demands are larger than the available water resources, the cropping patterns are revised in accordance with the suggestion from the Center and the Board of Directors so that the irrigation water demands meet the available water resources. WUO then informs the irrigation schedule to all the farmers.

(iv) Preparation of monthly or half-monthly irrigation water distribution schedule : Based on the irrigation schedule, a water distribution schedule, which mentions the time schedule and discharge of water delivery to every field is prepared monthly or semi–monthly by the irrigation inspectors and the irrigation operator.

(b) Operation of the irrigation system

(i) Santana headworks and the main canal

The Santana intake gates should be operated monthly or semi-monthly to regulate water in accordance with the irrigation schedule by INDRHI staff. When a flood comes, the intake gates should be fully closed and the sand-flushing gates are fully opened. The check gates on the main canal, which control the diversion discharge to the night storage pond are carefully adjusted in the opening degree once or twice a month in accordance with the irrigation schedule. The check gate has to be adjusted so that the stored amount of water reaches the required amount just

before the scheduled time to open the outlet gate. The turnout gates, which directly supply through small laterals to the fields will be operated daily usually opened in the morning and closed in the evening.

(ii) Night storage ponds and distribution systems

The outlet gate of the pond is opened usually at the morning time, and closed in the evening. Rotation irrigation will be made in each nucleus block and distribution and field canals convey water with their full capacity in order to keep high irrigation efficiency. Amount of water supply is mainly adjusted by irrigation supply hour and not by discharge.

(iii) Pump irrigation system

The pump irrigation system will be improved with the provision of a regulation pond. Water is to be distributed from the regulation pond usually during the daytime only as well as a lateral system in the proposed main canal system.

When the river water is abundant, the pumps are operated during the daytime so as to meet the irrigation water supply. However, when the river water is nearly equal to the water demand, the pump operation hours should be adjusted so that pump stations do not conflict each other. Further when the river water is less than the demands, the pump operation hours should be adjusted each other so that the river water can be taken continuously on a 24-hour basis as a whole.

(2) Maintenance

Field canals and drains will be maintained by farmers themselves of every nucleus as a communal work. The maintenance works are carried out two to four times a year.

Major irrigation facilities will be maintained by WUO. The irrigation engineer and the inspectors employed by WUO will prepare the annual maintenance and the maintenance staff will manage maintenance works mobilizing laborers with light equipment and tools. In case that the emergency repairing or a large-scale maintenance and repair is required, the Irrigation District Office will assist WUO in mobilizing heavy construction equipment.

8.9.3 Rural Infrastructure

Proposed rural water supply systems will be implemented under the management of INAPA technically and administratively from the detailed design stage. Their operation and maintenance will also be under its responsibility just like the other water supply systems. Their operation includes 1) pump operation, 2)management of settling pond, filtration gallery, and elevated water tank, and 3)operation and replacement of chlorination plant, etc. Since the water supply system will be established on the INDRHI's irrigation canal system, water will be reserved in the night storage pond during the canal maintenance period. The water charge to INDRHI will be paid following the agreement between INDRHI and INAPA. Collection of water charges from the beneficiaries will be made by the INAPA district offices according to its tariff, while maintenance works of the water supply system will also be carried out by its district offices.

The community center will be managed under the responsibility of the WUO itself. It will be operated to actively receive the villagers' level communication meeting and recreation activities through the organization of the local government or villagers' groups.

8.9.4 Environmental Conservation

The project, which requires maintenance, is "Green Belt Formation for Waterfront Conservation". For the planted bamboo and shade trees, maintenance for 6 months is required. The maintenance consists of weeding and fertilizing (5 oz. (140g) per seedling) once every 2 months, or 3 times in 6 months. In case some seedlings die, a supplement planting is required. It is estimated that the number of seedlings for the supplement planting is 360 for bamboo and 5 for shade trees (10 % of the number of total plantings). After the 6 months, since the bamboo is tall enough to win competition with weeds, little or no care is required.

9. IMPLEMENTATION PLAN AND ORGANIZATION

9.1 Implementation

9.1.1 Approach to the Project Implementation

The formulated agricultural development project includes an agriculture and agricultural support services project plan, overall water management plan, irrigation development and water management in the field improvement plan, rural infrastructure improvement plan and environmental conservation plan as shown below:

(1) Agriculture and Agricultural Support Services Plan

- Project for strengthening research and extension services
- Project for Strengthening Credit Services
- Agricultural Cooperative Model Project and Market Information System Project

(2) Overall Water Management Plan

- Yaque del Sur River Water Management Center Project

(3) Irrigation Development and Water Management in the field Improvement Plan

- Improvement Project of Villarpand Intake Weir
- Improvement Project for Irrigation Facilities including Santan Intake Weir
- Project of Strengthening Water User's Association

(4) Rural Infrastructure Improvement Plan

- Rural Water Supply Project
- Project for Community Center Development

(5) Environmental Conservation Plan

- Green Belt Formation Project for Waterfront Conservation
- Environmental Monitoring Program in Rincon Lagoon

The project covers sub-projects with different components in works mentioned above. In order to comprehensively and efficiently implement these projects, It is proposed to establish an advisory committee composed of representatives from relevant ministries, governors of the related provinces, representative of farmers and members of private sectors. Also a unified executing organization composed of the qualified staff assigned from the relevant ministry, local governments, and agencies. A farmer's participatory approach to the Project is first planned for the implementation of the Project. The project implementation office shall be in operation from the preparation stage and the detail stage not only for survey and design but also for land acquisition, arranging beneficiary's participation for construction and operation and maintenance.

9.1.2 Implementation Schedule

It is planned that implementation period is set for 5 years taking into account the content of works, scale of works, available working days, etc for the sub-projects. The project will be performed by two steps, phase-1 and phase-2.

Phase-1 is composed of the following works:

(1) Design and Improvement of Villarpand intake weir, which should function fair delivery of river water to Azua irrigation district area and Yaque del Sur/Lago/Enriquillo irrigation district areas including the irrigation project here

(2) Design and Construction of a Yaqu del Sur water management center building and installation of urgent communication equipment and training

(3) Design and Improvement of Santana intake weir and improvement for irrigation facilities of the irrigated land on the right side of the Yaque del Sur River that irrigation water is provided by gravity system. (Tamayo irrigation system ; about 600ha)

(4) Strengthening and fostering of water user's organization in the irrigated land mentioned in item (iii)

(5) Preparation of cadastral maps of the irrigated land mentioned in item (iii) and provision of services for farmers to get definite land title

(6) Reinforcement of market information system in the Project area

(7) Design of the Improvement project of irrigation facilities for the remaining area

Phase-2 is composed of the following works:

(1) Improvement of irrigation facilities for the remainder of the irrigated land

(2) Strengthening and fostering of water user's organization for the remainder of the irrigated land

(3) Preparation of cadastral maps of the irrigated land for the remainder of the irrigated land and provision of services for farmers to get definite land title

(4) Installation of remaining communication equipment and training

(5) Design and Construction of rural water supply systems

(6) Design and Project for strengthening research and extension services

(7) Continuous operation of market information system project

(8) Design and Construction Environmental conservation project

(9) Design and Monitoring work

The implementation schedule is shown in Figure 46.

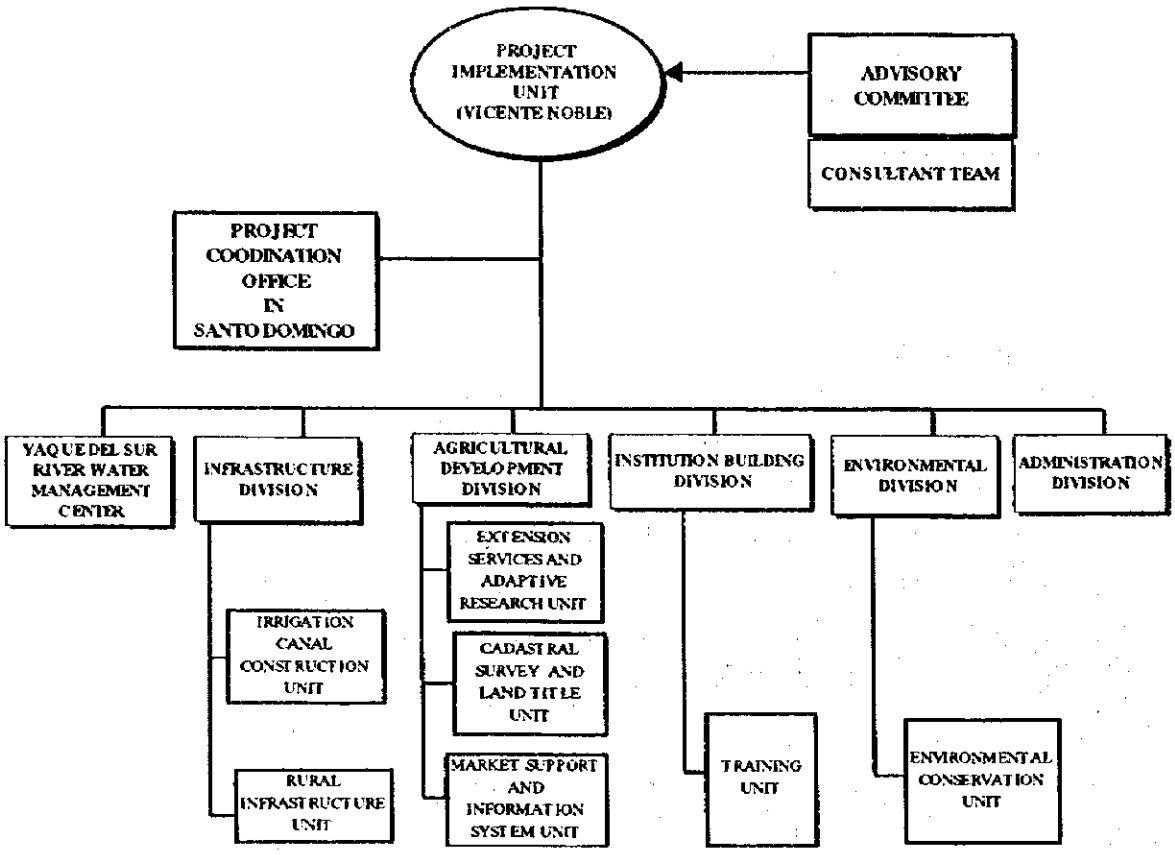
9.2 Organization and Management

A new project implementation office will be established under the supervision of the Director of INDRHI to execute the Project. The proposed project executing organization is shown below. In order to comprehensively and efficiently implement the sub-projects, an advisory committee will be instituted. A project office in Santo Domingo will be established to coordinate the Project with headquarters of INDRI and other related

ministries. Under the general manager of the Project implementation office, 5 divisions and one center will be instituted to carry out surveys, design and construction of the Projects.

After the implementation of the Project, the Project implementation office will be phased out except for the Yaque del Sur River water management center. The Yaque del Sur River water management center, which should function to deliver fairly river water to Azua irrigation district area and Yaque del Sur/Lago Enriquillo irrigation district area, will continue its function not under the Azua irrigation district office but under the supervision of the headquarters of INDRHI at Santo Domingo.

After the implementation of the Project, operation and management for Villarpand intake weir and Yaque del Sur River water management office will be made by the control of the headquarters of INDRHI. All irrigation systems except Santana intake weir are in principle managed by water user's organizations but INDRHI has ownership of all the irrigation systems. The Yaque del Sur irrigation district office and Barahona Sugar corperation will do operation and management of Santana intake weir. INDRHI will take the rural water supply systems over INAPA that should manage. Community centers will be managed by water user's organizations.



10. COST ESTIMATE

10.1 Conditions of the Cost Estimate

The project cost is estimated on the basis of preliminary design of the Project facilities with the following assumptions.

(1) The exchange rate of US$1.00=DR$15.5=112 Japanese yen is applied

(2) Construction works will be executed on a contract basis. The contractors will provide the construction machinery and equipment required for the construction. Therefore, depreciation costs of machinery and equipment are considered in the estimate of construction cost.

(3) The unit prices are analyzed on the basis of basic unit cost and working rate of labor and materials is basically quoted from the unit cost officially used by INDRHI in January 1999. The unit prices of the works were divided into the foreign currency and the local currency portion.

(4) Engineering service and administration cost are estimated at 15% and 5% of direct construction costs, respectively. Physical contingency is estimated at 10% of the direct construction costs.

(5) The price contingency is taken into account at annual escalation rate of 15% for the local currency portion and 2.0% for the foreign currency portion.

10.2 Cost Estimate for the Projects

10.2.1 Estimate of Construction Cost

The project cost comprises the construction cost, procurement cost of equipment and machinery, engineering services cost, administration cost and contingencies. The total cost of the proposed project in the Project area is summarized below and the details are shown in Table 30.

Project	Local currency (1,000 DR$)	Foreign currency (1,000 R$ equivalent)	Total cost (1,000 DR$)
Overall water management project (Yaque del Sur Water management center project)	46,328	185,313	231,641
Improvement project of Villarpand intake weir*	5,793	15,143	20,936
Improvement project of the irrigation facilities and Water Management project*	198,519	484,022	682,541
Rural infrastructure project	10,478	23,788	34,266
Extension/research project**	30,575	2,913	33,488
Credit project**	24,303	1,340	25,643
Agricultural cooperative and information system project**	9,287	4,401	13,688
Environmental conservation project	1,966	1,835	3,801
Total	327,250	718,755	1,046,005

*:irrigation project, **:agricultural support project

10.2.2 Fund Requirement

The annual disbursement schedule for the Project execution is worked out based on the implementation schedule and price escalation factor, as shown in Table 31 and fund requirement is DR$ 1,196 million.

10.3 Operation and Management Cost

The O&M cost comprises the administration cost, equipment cost, and O&M cost of the Projects. The annual O&M cost in the full operation stage for the respective projects is summarized below:

Project	Total O&M cost			O&M cost for the project	
	Administration cost (1,000DR$)	O&M of facilities (1,000DR$)	Total (1,000 DR$)	Allocated rate (%)	Economic O&M cost (1,000 DR$)
Overall water management project (Yaque del Sur water management center project)	2,484	4,439	6,923	15.2	1,052
Improvement project of Villarpand headworks	-	16	16	16.5	3
Improvement project of irrigation facilities and Irrigation water management project	5,227	1,429	6,656	81.8	5,445
Rural infrastructure	605	108	713	100	713
Total	8,316	5,592	14,308		7,213

*: irrigation project, **:agricultural support project

10.4 Replacement Cost

The metal works of irrigation facilities and equipment will be replaced periodically. The O&M equipment and gates should be replaced every 5-10 years and 20 years after commencement of the Project. The replacement cost for the respective Projects is summarized below:

Project	Metal &Equimpment	Durability (year)	Total Replacement cost (1,000DR&)
Overall water management project(Yaque del sur water management center project)	Outside of house	10	20,000
	indoor	25	25,000
Improvement project of Villarpand intake weir*	gates	20	6,226
Improvement project of the irrigation facilities and Water management project *	Gates and pumps	20	12,405
Rural infrastructure project	Gates and pumps	20	2,602

*: Irrigation project

11. PROJECT EVALUATION

The project evaluation includes an assessment of project feasibility regarding economic, financial, environmental, socio-economic aspects. The economic feasibility is first evaluated by calculating the Internal Rate of Return (IRR). Sensitivity analysis is also performed in order to evaluate the soundness of economic viability of the Project against changes in benefits, the construction period, and construction costs.

Financial evaluation is carried out by analyzing the effect of the Project on the farm economy for typical types of farmers.

The socio-economic and environmental impacts of the Project are evaluated.

11.1 Economic Evaluation

11.1.1 Assumptions

(1) Basic Assumption

The economic evaluation is made on the following basic assumptions:

(a) The economic life of the Project is 50 years

(b) All prices expressed are 1998 prices

(c) The exchange rate of US$1.00=DR$15.5 is applied

(d) Transfer payment such as interests and taxes are excluded

(e) Standard conversion factor of 0.87 is applied to the price of non-tradable goods and services

(f) Shadow price factor of 0.44 is applied to unskilled labor

(g) The project costs of the sub-projects such as extension/research project, credit project, agricultural cooperative and information system project and environmental conservation project is excluded in the economic evaluation.

11.1.2 Economic Project Costs

(1) Capital Cost

The economic construction cost is estimated by applying the construction conversion factor to the financial construction cost as shown below. Since the overall water management project covers the whole basin, improvement project of Villarpand intake weir covers the areas including Azua, Lago/Enriquiyo irrigation district areas, and Improvement project of irrigation shares function of Santana intake weir and main canal with CEA sugar cane farms, capital cost is allocated to the Project as follows:

Project	Total economic construction cost			Economic construction cost for the project	
	Financial cost (1,000 DR$)	Construction conversion factor (%)	Economic cost (1,000 DR$)	Allocated rate (%)	Economic cost (1,000 DR$)
Overall water management project(Yaque del sur water management center project)	231,641	97.1	225,448	15.2	34,268
Improvement project of Villarpand intake weir	20,937	88.8	18,582	16.5	3,066
Improvement project of irrigation facilities and Irrigation water management project	682,541	81.6	558,692	81.8	558,692
Rural infrastructure	34,266	88.9	30,431	100	30,431
Total	969,385		833,153		626,457

(2) Annual Operation and Maintenance Cost

Economic annual operation and maintenance cost is estimated by applying financial O&M cost to construction conversion factor. The depreciation cost of O&M equipment and gate is taken as the replacement cost. Economic annual O&M cost is estimated in the following table. As in the above table, annual operation and maintenance cost of the Project with consideration of cost allocation is calculated.

Project	Total economic O&M cost			Economic O&M cost for the project	
	Financial O&M cost (1,000 DR$)	Construction conversion factor(%)	Economic O&M cost (1,000 DR$)	Allocated rate (%)	Economic O&M cost (1,000 DR$)
Overall water management project (Yaque del Sur water management center project)	6,923	82.3	5,697	15.2	866
Improvement project of Villarpand intake weir	16	62.5	10	16.5	2
Improvement project of irrigation facilities and Irrigation water management project	6,656	55.6	3,699	81.8	3,025
Rural infrastructure	713	68.6	489	100	489
Total	14,308		9,895		4,382

(3) Replacement Cost

It is assumed that O&M equipment and gates are replaced every 5 to 10 years and 20 years. Economic replacement cost is estimated by applying financial cost of O&M equipment and gates to construction conversion factor is as follows:

Project	Metal & Equipment	Durability (year)	Total Economic Replacement cost (1,000DR&)
Overall water management project (Yaque del sur water management center project)	Outside of house	10	2,830
	indoor	25	3,538
Improvement project of Villarpand intake weir*	gates	20	336
Improvement project of the irrigation facilities and Water management project *	Gates and pumps	20	3,087
Rural infrastructure project	Gates and pumps	20	2,575

*: Irrigation project

11.1.3 Economic Project Benefits

The project benefit consists of irrigation benefit and municipal water supply benefit in the Project.

The irrigation benefit is defined as the difference in primary profit from crops between the future with project and without project conditions. On the basis of production cost and gross income, the primary profit from crops per ha was estimated for both with and without project conditions. In this study the primary profit from crops under the without project condition was considered as the profit at present. The primary profits from crops under both the without project and with project conditions are shown in Table 32. The target yield of crops is assumed to reach 5 years. And irrigation benefit is estimated under the assumption that the irrigation projects formulated in the master plan are completed within 10 years. Irrigation benefit at the full stage is shown in Table 33.

The rural water supply benefit is defined as substitution cost of the present water fee of 0.048 DR$/litters that water tank lorry carries water to the Project sites. The municipal water supply benefit is generated after the 5th implementation year. Total rural municipal water supply benefit is estimated at Table 34.

11.1.4 Economic Evaluation

The economic internal rate of return is calculated on the basis of cost and benefit flow as shown in Table 35. The internal rate of return is estimated at 23%.

11.1.5 Sensitivity Analysis

Sensitivity analysis is carried out to evaluate the soundness of the Project against possible adverse changes in the future in the following cases:

(1) Cost overrun by 20%

(2) Reduction of irrigation benefit by 20% due to decrease of crop yields and prices

(3) Combined effect of case (1) and (2)

Case	Internal rate of Return(%)
(1)	20.1
(2)	19.5
(3)	16.9

11.2 Financial Analysis

In order to evaluate the Project from the financial aspect of the farmers, a farm budget analysis on different sizes of farmers is made under both futures with project conditions. After the implementation of the Project, the Project will provide the basis for the introduction of improved irrigation farming. As a result, increase of unit yield of crops and cropping intensity will be much expected. A farmer's income will increase and farmer's economic situation will much improve, which will offer incentive to the farmers in the Project area.

The results of farm budgets for the farmers in the Project area are summarized below: Details are shown in Table 36.

Item	Small farmer	Medium farmer	Large farmer
Farm size (ha)	0.61	1.3	4.3
Family size (person)	5	5	4
Agricultural income (DR$)	64,013	136,422	451,243
Non-farm income(DR$)	11,500	11,500	0
Total Income (DR$)	75,513	147,922	451,243
Production cost (DR$)	8,997	25,147	96,030
Living expenditure (DR$)	44,616	74,035	145,275
Total expenditure	53,613	99,182	241,305
Surplus (capacity to pay) (DR$)	21,900	48,740	209,940

As shown in the above table, net reserve or the capacity to pay is expected to be 21,900 DR$ for the small farmer, 48,740 DR$ for the medium farmer and 209,940 DR$ for the large farmer, respectively. On the other hand, operation and maintenance cost of irrigation systems with project condition is estimated at DR$ 1,100/ha and the farmers in the Project area will be able to afford to pay for O/M cost.

11.3 Socio-Economic and Environmental Assessment

In addition to the direct benefits counted in the Project evaluation, various secondary and intangible benefits and favorable socio-economic impacts are expected.

11.3.1 Social-Economic Impacts

(1) Social Change

The result of the EIA points out several positive impacts of the Projects to the socio-economic condition concerning irrigation facilities and WUO. This does not simply mean that more agricultural production and higher income are brought to local farmers, but also that changes of essential structure or characteristics of the rural society will be brought. In this section, such essential social changes are studied, based on the case studies in San Juan and Azua where the similar projects to the proposed projects already has been implemented.

An essential rural problem in this country is that the rural society is not democratic enough. The problem consists of 2 factors, which are first, lack of force among small farmers to organize or combine by themselves; and second, the centralization of power, for example, to control water distribution. These 2 factors interfere with the farmer's thinking and activities to resolve the problems and to improve their life by themselves.

The result of the case study is shown in the Table 37. From the result of the case studies, several changes in system of water distribution process are observed. What is even more important, the Project impacts have extended to the rural social system. In the Project area, it is also expected that same kind of changes will occur, which are concretely:

- Leaders such as water distributor of organization are elected by all users. As a result, a more democratic rural society will be built.
- Organization with stratum structure, consisting of nucleus, committee and association, is built. As a result, the power will be decentralized and the water management can be performed more efficiently and democratically.

- In every level of the organization, the decisions are made through discussions among water users. As the result, the decision process has become more democratic, and user's consciousness on social participation has become higher.
- Collaborated works for the irrigation facility management are done by all users. As the result, user's consciousness on social participation has increased.
- A strong rural society based on the WUO is able to become a powerful party against powers of outside areas.

Through the process of organization building and decentralization of the power, the society will become more democratic. In the process of the democratic society building, the local people will be empowered and at the same time the society to which they belong will be also empowered. With the empowered people, a society which can achieve self-development will be built up.

(2) Increase in employment opportunity and technical transfer

It is estimated that the Project will generate employment opportunities totaling about 0.31 million man-days of unskilled labors during the construction period. Furthermore, the employees will gain more work experience and technical skills not only in the irrigation sector but also in the commercial sectors. The opportunity for self-employment in and around the Project area will be increased through the Project and this will activate monetary movement in the regional economy. The increased crop production will generate commercial activities.

(3) Improvement of farm products

The quality of plantain and other crops will be much improved by the sufficient water supply, which minimizes crop damage and assures uniform maturing of plantain. Such improved quality would increase the marketability of the products.

(4) Improvement of the nutritional status of the rural population

The project will contribute to the improvement of the nutritional status of the rural population by supplying more staple foods (plantain).

(5) Improvement of the present water supply condition

The irrigation canals to be constructed for distributing water to the fields are water sources for the everyday use of the local residents and the rural water supply system will improve the health conditions of the local people.

(6) Improvement of local transportation

The local transportation system will be improved by the construction of the O&M road along the irrigation canals. The road extension will not only enhance the economic activities, but will also contribute to accessibility and communication.

(7) Energy aspect

The proposed irrigation project will change the part of the existing pump systems to gravity systems in which irrigation water is directly supplied through the new main canals by Santana intake weir. The operation cost of energy is greatly decreased.

11.3.2 Environmental Impact Assessment (EIA)

The result of the Initial Environmental Examination (IEE) (see 4.10) points out some possible negative impacts by the Project implementation. In agricultural development projects, however, negative impacts do not always happen. Since the Project does not provide a large construction works, it is friendly enough for the environment, and bring many positive impacts. Therefore in EIA to be conducted in this section, not only the negative impacts but also the positive impacts are foreseen and evaluated.

The Environmental Impact Assessment (EIA) is conducted for the all proposed projects, and nine environmental items as shown in the following table are examined. The result of the EIA is shown in this figure and in Table 38.

Figure Result of EIA

		Irrigation Water Management Improvement Project	Irrigation Facility Improvement Project	Villarpando Headworks Improvement Project	River Water Management Reinforcement Project	Project of Overall Water Management in Yaque del Sur River Basin	Project for Strengthening Agriculture Support Service	Rural Water Supply Project	Community Hall Construction Project	Green Belt Formation for Waterfront Conservation	Lagoon	Environmental Monitoring Program in Rincon
Socio-economic issue	Substantial change in way of life	◎	○	—	—	—	◎	○	○	○	—	
	Change in economic activities of local people	○	◎	○	○	○	◎	○	—	—	—	
	Change in water use condition	◎	◎	◎	◎	◎	—	◎	—	—	—	
	Change in social and institutional structures	○	—	—	—	—	—	—	○	—	—	
Health and sanitary	Increase of agrochemical use	—	—	—	—	—	○	—	—	—	—	
	Increase of water born diseases	—	△	—	—	—	—	◎	—	—	—	
Natural environmental issue	Change in vegetation and land use	—	△	—	—	△	—	—	△	◎△	◎	
	Soil salinization	—	△	—	—	—	—	—	—	—	—	
	Water contamination and deterioration of water quality	—	—	×	—	—	○×	—	—	—	○	

Note: ◎Grate positive environmental impacts are foreseen, ○Positive environmental impacts are foreseen, △Although some negative impacts are foreseen, they will be reduced by countermesures; × Small negative impacts or temporaly impacts are foreseen, —No change.

11.3.3 Overall assessment for the Project

The Project is technically sound and economically feasible. Moreover, the Project will provide substantial and sustainable socio-economic benefits not only to the Project area but also to the Yaque del Sur River Basin and the southwest region.

Almost all of the Project areas are already developed as agricultural land, and valuable vegetation and habitat areas do not exist. Also the Project does not have components with large scale earth works. Therefore few serious negative environmental impacts will occur by the Project implementation.

On the other hand, several positive impacts for the rural society are expected as described in the previous section. The objective of a series of the Project concerning agricultural development is to improve the condition of the water supply and raise the agricultural production and farmer's income. However, what is even more important, the implementation of the Project will be able to become a trigger of starting the social changes to realize a democratic and economically and mentally rich society with empowered people.

12. CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

(1) Based on the results of the feasibility study on the agricultural development in the lower Yaque del sur river, the agricultural development in the lower Yaque del Sur River should be integrated with the following points for success:

(i) Improvement of irrigation facilities such as Villarpand headworks and the existing irrigation facilities.

(ii) Strengthening of water user's organization for operation and maintenance of irrigation systems by water user's organization.

(iii) For effective use of river water, the Yaque del Sur Water Management Center will be newly instituted.

(iv) Construction of rural infrastructure of rural water supply and multipurpose community centers to improve quality of life of farmers.

(v) Strengthening agricultural support services relevant to a research program of adaptive and applied on-farm research for plantain, education and training for extension workers along with leaders of nucleus of water users to develop their capacity, preparation of cadastral ledgers and service for land resisters, establishment of a model agricultural cooperative land and a market information system.

(2) The Project is technically sound, economically feasible, financially justifiable and environmentally sound. Moreover, the Project will provide stabilization of the farmer's economic situation by increasing farm income, improvement of life quality of the farmers and (iii) creation of job opportunities for local people and improvement of social welfare.

12.2 Recommendations

(1) It is recommended, based on the above conclusions, that the Project should be implemented as early as possible. It is also recommended that the Project should be implemented stepwise as Phase-1 and Phase-2. In Phase-1, improvement of Villarpand headworks and the Yaque del Sur water management center project would be performed because more precise discharge control at Villarpando is essential for the Project. In an irrigation system (Tamayo system with about 600 ha) in the uppermost area of the Project area, fostering water user's organization (WUO) and operation and management of the irrigation system including a night storage pond under WUO, which are proposed in the Project, should be undertaken bchorehand. And constraints encountered should be identified. In parallel with the above, education and training for extension workers and nucleus leaders of irrigation water's organizations relevant to Tamajo irrigation system will be provided. Also cadastral ledger and legal services on land registration will be provided to relevant farmers. Based on the results of the Phase-1, the Project should be smoothly and efficienty performed.

(2) The results of the non-uniform flow analysis indicate that carrying capacity of the lower reaches of the Yaque del Sur River is about 100 m^3/sec. It should be noted that the flood flow of 1 in 50 years, which is estimated at about 4,000 m^3/sec almost overflows before Canoa. During the flood periods, the river water overflows from the river course on the downstream stretch of the Yaque del Sur River. It is recommended that a master plan study for flood control in the lower Yaque del Sur River be carried out.

Tables

Table 1 List of Counterparts and JICA experts

Name	Official Position
Counterparts	
Gilberto Reynoso	Chief Counterpart,
Rafaela Lima	Infrastructure engineer, INDRHI
José Ogando Montero	Agronomist, INDRHI
Nelson E. De Los Santos Mateo	Structural engineer, INDRHI
Fausto Colon	Structural engineer, INDRHI
Mayra A. Sánchez Santana	Hydrologist, INDRHI
Yasiris González Pineda	Environmentalist, INDRHI
Alice E. Bautista R.	Sociologist, INDRHI
Sergio J. Tejada R.	Irrigation and drainage engineer, INDRHI
Felipe Felix	Infrastructure engineer, IAD
Martha Corsino	Infrastructure engineer, IAD
Antonis Mesa	Agronomist, SEA
JICA experts	
Kenjiro Onaka	Team leader
Hiroyosi Matsuura	Irrigation and drainage engineer
J. Delos Santos	Agricultural support expert
Luis Rosado	Agronomist
Nobuo Sambe	Hydrologist
Kunita Okuwa	Infrastructure engineer
Fumiaki Murakami	Structural engineer
Masahiro Ichikawa	Environmentalist
Hidetoshi Kakiuchi	Survey engineer
Tsuyoshi Seino	Survey engineer

Table 2 Wet and Dry Years in the Study Area

Year		La Florida Mean (mm)	(yrs)	San Juan Mean (mm)	(yrs)	Azua Mean (mm)	(yrs)	Barahona Mean (mm)	(yrs)	Tamayo Mean (mm)	(yrs)
1961		1089.0	-4			614.8					
1962		973.0	-9			728.6	+3				
1963	W	1631.0	+8	1193.5	+7	1475.4	+113				
1964		751.0	-110	897.7		473.5	-5				
1965		1257.0		1511.5	+34	365.0	-17				
1966		915.0	-15	1137.1	+5	704.0	+3	1051.7		509.1	+4
1967	D	659.0	-629	533.2	-54	358.8	-18	724.6	-9	265.0	-10
1968		1214.0	-3	1052.5	+4	505.2	-4	746.8	-8	289.1	-7
1969	W	1599.0	+7	990.5	+3	699.3	+3	1346.5	+8	524.1	+4
1970		1545.0	+5	1157.1	+5	499.0	-4	887.0	-4	382.0	-3
1971		1344.8	+3	1151.0	+5			914.5	-3	296.2	-6
1972		1160.5	-3	1096.2	+4			1169.5	+4	950.6	+97
1973		1316.0	+3	708.9	-7			608.6	-32	281.0	-8
1974		1454.0	+4	848.9	-3	390.0	-12	1253.1	+5	449.8	+3
1975		1672.0	+9	792.3	-4	578.4	-3	789.9	-6	390.0	-3
1976	D	1226.0	-3	548.5	-42	454.7	-6	742.2	-8	361.6	-3
1977		1415.0	+4	648.1	-11	372.0	-15	1002.9		499.0	+4
1978	W	1582.0	+6	1138.9	+5	670.8	+3	1121.5	+4	404.6	
1979	W	1405.0	+4	1284.0	+10	1646.5	+287	1740.0	+51	811.5	+33
1980		1386.3	+3	791.4	-4	674.6	+3	1053.6	+3	402.7	
1981		1149.7	-4	1269.8	+9	1173.1	+24	1435.3	+12	481.7	+4
1982		1513.3	+5	733.2	-5	408.4	-9	815.3	-5	271.5	-9
1983		1471.3	+4	1010.1	+3	563.9	-3	1183.0	+4	341.8	-4
1984		1355.1	+3	903.8		567.7	-3	584.1	-46	248.7	-14
1985		1297.3		788.5	-4	776.6	+4	997.8		655.3	+10
1986		1465.6	+4	883.9	-3	776.3	+4	1080.0	+3	348.8	-4
1987	W	1701.6	+10	1123.7	+5	774.8	+4	1423.9	+11	476.9	+3
1988		1215.0	-3	1015.9	+3	710.9	+3	704.7	-11	254.4	-12
1989		1085.5	-5	1030.2	+4	564.4	-3	1011.6		303.6	-5
1990		1569.3	+6	905.0		664.6	+3	1075.2	+3	354.1	-4
1991	D	917.9	-15	512.3	-82	480.2	-5	983.1			
1992	W	1433.9	+4	1267.9	+9	649.8		1112.5	+3	497.2	+4
1993		1222.6	-3	968.5	+3	813.3	+5	968.5		449.6	+3
1994		917.9	-15	664.6	-10	781.6	+4	1622.4	+28	557.4	+5
1995		1433.9	+4	866.0	-3	818.7	+5	945.5	-3	812.9	+33
1996		1222.6	-3	906.3		576.4	-3				
1997											

Note: ex. "-82"= dry year with a probability of 1 in 82 years recurrence
"+9"= wet year with a probability of 1 in 9 years recurrence

Source: Calculatred by the Study Team using the records by National Meteorological Office and National Hydrological Office of INDRHI

Table 3 **Dependable River Discharge at Each Hydrological Check Point**

unit: m³/sec

Code	Station	Period	Probability	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Remarks
D1	Sabaneta	1968-1980	Mean	5.0	4.6	4.2	4.3	7.2	9.4	10.1	10.8	17.1	18.1	10.8	7.1	
			80%	4.1	3.8	3.4	3.1	5.0	5.4	6.2	6.9	12.3	13.9	8.7	6.4	
			90%	3.8	3.5	3.0	2.6	4.3	4.3	5.0	5.7	10.6	12.4	7.9	6.0	Before Sabaneta Dam
D1a	Guazmal	1956-1979	Mean	5.5	4.3	3.9	4.9	9.6	12.7	12.6	14.1	18.4	20.2	13.2	8.1	
			80%	4.2	3.2	2.5	2.9	5.4	6.4	7.2	8.7	12.9	12.5	9.0	5.5	
			90%	3.7	2.8	2.1	2.4	4.2	4.9	5.8	7.1	11.1	10.3	7.6	4.7	Before Sabaneta Dam
	Guazmal	1980-1992	Mean	4.3	3.8	3.1	2.8	6.8	6.6	7.8	7.6	8.8	9.8	5.9	4.8	
			80%	2.4	2.7	2.3	1.8	2.4	3.0	3.7	4.3	5.5	5.7	4.6	3.2	
			90%	1.9	2.3	2.0	1.5	1.7	2.2	2.8	3.4	4.5	4.6	4.1	2.6	After Sabaneta Dam
D2	Sabana Alta	1979-1992	Mean	7.4	5.7	4.5	5.8	20.5	20.2	15.8	15.8	25.5	26.3	19.2	10.7	
			80%	5.0	3.4	3.7	3.6	7.0	7.8	6.7	9.2	12.9	17.7	13.9	7.5	
			90%	4.2	2.7	3.4	3.0	4.7	5.5	4.9	7.4	9.8	14.9	12.1	6.4	
D3	El Puente	1957-1979	Mean	12.9	9.7	8.4	11.2	20.3	29.2	20.9	19.8	30.1	33.0	28.0	20.6	
			80%	9.1	7.0	6.0	6.7	11.8	14.9	11.9	13.5	20.2	24.1	18.3	12.6	
			90%	7.9	6.1	5.2	5.4	9.5	11.4	9.4	11.5	17.1	20.9	15.3	10.3	Before Sabana Yegua Dam
	El Puente	1980-1993	Mean	24.4	24.5	22.0	20.6	21.6	25.5	29.1	21.3	20.4	21.5	21.7	21.2	
			80%	16.9	17.5	15.2	16.0	15.1	13.2	17.2	18.2	15.6	18.8	18.1	18.7	
			90%	14.5	15.2	12.9	14.1	12.9	10.2	13.9	16.9	14.5	17.7	16.6	17.6	After Sabana Yegua Dam
D4	Villarpando	1960-1982	Mean	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	23.0	20.9	28.4	39.8	42.7	33.0	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	
D6a	Quita Corasa	1973-1979	Mean	22.5	17.5	16.5	14.8	31.2	45.7	29.5	36.1	47.5	56.6	43.0	37.8	
			80%	10.5	8.0	8.8	8.7	14.2	14.7	13.4	19.5	38.8	44.6	28.5	15.9	
			90%	-	-	-	-	-	-	-	-	-	-	-	-	
D6b	Los Guiros	1986-1992	Mean	18.8	16.9	16.8	18.3	24.1	25.3	23.7	26.9	40.2	38.5	28.4	20.3	
			80%	15.6	14.0	12.9	12.5	11.4	12.2	13.1	20.1	26.1	28.7	21.7	17.1	
			90%	-	-	-	-	-	-	-	-	-	-	-	-	
D6c	Conuquito	1984-1993	Mean	19.0	17.4	17.8	17.4	25.2	29.4	22.4	21.7	33.4	29.0	28.1	21.9	
			80%	13.2	12.7	13.0	11.4	13.0	12.8	12.7	14.3	17.8	19.2	18.0	16.7	
			90%	11.2	-	11.3	-	-	9.4	-	-	13.7	-	-	-	
D8a	Palo Alto	1968-1979	Mean	6.3	3.0	3.3	5.3	19.0	29.3	21.6	20.4	43.6	50.2	33.5	19.4	
			80%	2.5	1.1	0.9	0.8	5.5	9.7	4.8	9.8	27.6	30.5	19.3	7.2	
			90%	1.8	0.7	0.6	0.4	3.5	6.4	2.8	7.3	22.7	24.7	15.4	4.9	
	Palo Alto	1980-1990	Mean	9.8	7.8	6.6	7.0	17.1	18.1	20.3	12.1	17.4	21.6	14.5	9.1	
			80%	4.8	4.2	3.8	3.4	5.6	6.0	4.0	5.5	7.1	10.8	5.8	6.0	
			90%	-	-	3.0	2.6	-	4.0	-	4.0	5.1	8.2	4.1	-	
D10	El Cacheo	1957-1993	Mean	2.4	2.0	1.9	2.4	5.3	7.2	5.8	5.8	7.8	7.8	5.5	3.4	
			80%	2.0	1.6	1.4	1.4	2.8	4.2	3.2	4.0	4.7	5.4	3.8	2.5	Mijo river
			90%	1.8	1.5	1.2	1.2	2.1	3.4	2.6	3.4	3.8	4.6	3.2	2.2	
D11	Hato Viejo	1972-1980	Mean	0.7	0.4	0.4	0.4	1.0	0.9	1.1	1.4	2.4	2.3	1.8	1.3	
			80%	0.6	0.3	0.2	0.2	0.4	0.3	0.5	0.8	2.1	1.9	1.4	1.0	Guanito-San Juan
			90%	-	-	-	-	-	-	-	-	-	-	-	-	
	Hato Viejo	1981-1992	Mean	1.9	1.7	1.5	1.3	1.9	1.6	2.0	2.3	2.8	3.3	2.8	2.1	
			80%	1.6	1.5	1.2	1.0	1.1	1.0	1.4	1.7	2.2	2.6	2.4	1.8	
			90%	1.4	1.4	1.1	0.9	0.9	0.9	1.2	1.6		2.3		1.6	
D12	Vallejuello	1978-1995	Mean	0.52	0.37	0.43	0.51	0.70	0.78	0.69	0.79	0.73	0.62	0.57	0.51	
			80%	0.32	0.22	0.23	0.26	0.34	0.28	0.23	0.21	0.25	0.30	0.25	0.27	Vallejuelo
			90%	0.26	0.18	0.18	0.20	0.26	0.19	0.15	0.12	0.17	0.22	0.18	0.21	

Table 4(1/2) Present Farming Practices of Main Crops in the Study Area (1/2)

Farming Practices	Rice	Red Bean	Plantain & Banana
Land Preparation	62 % of rice farmers plow using tractors, and the rest use animal traction. About 60 % rice farmers make puddling using animal traction, and the rest use tractors. For land leveling 65 % of farmers use animal traction. Animal traction is used mainly by small farmers.	Most bean farmers in irrigated lands use tractors for plowing; but in rainfed lands use animal or manually. Majority of small farmers in irrigated lands use animal traction for Harrowing. Border stripes are made using animal traction.	Majority of plantain and banana farmers use tractors for land harrowing and less farmers use animal traction. Holes are open manually at distance varying between 3m by 3m or 2.5 m by 2.5 m.
Planted Varieties	Half of farmers use Isa-40, 24 % use Juma-58, others use Taniloka, Graciolo, Mingolo, Isa-21, IZ-39, Diente de Gato, and IR-6.	The bean varieties commonly planted are PC-50, Jose Beta, P. Checa	Plantain varieties are "Macho por Hembra", "Barahonero", Banana varieties are "Cavendish", "Media mata", and "Gross Michel"
Planting Method	About 45 % of rice farmers use seeds that they keep from the previous harvest, while the rest get seeds from the rice mills or from other farmers. Only small percentage of rice farmers use certified seeds. Amount of seeds is from 120 to 150 kg/ha. All rice farmers pre-germinate the seeds previous to planting. 90 % of farmers plant by the direct seedling method, only 10 % use the transplanting method. Majority farmers plant rice from May to July, but it vary depending on water availability.	Planting period is fixed by SEA regulation from beginning Nov. to mid Dec. About half of farmers use planting materials that they buy from SEA, the rest use material kept from previous harvest or buy noncertified seeds. Average amount of seeds is 105 kg/ha. Almost all farmers plant within borders stripes and use planting machine pulled by animal (horse) traction. Planting density vary widely among farmers.	Planting material are obtained mostly from neighbor farmers and from SEA. Planting density vary from 1,300 to 1600 plant/ha. Fertilizers and some insecticides are located on the bottom of the hole, previous to planting.
Fertilization	All rice farmers apply fertilizers. Majority (87%) apply 3 times. 40 % of farmers use compound formulas such as 15-15-15, 12-24-12, or 16-20-0, and many farmers use only nitrogen fertilizers such as Urea or Ammonia sulfate. Average amount of fertilizer applied is 400kg/ha of compound fertilizer, and 100 kg/ha of Urea. Farmers drain the fields from 2 to 6 days before applying fertilizers.	All farmers apply fertilizers. Half of bean farmers in irrigated areas make 2 application of fertilizers, one compound such as 15-15-15 or 16-20-0 and a second application of Urea. Half of farmers only make the first application. Soil analysis is not done by majority of small and medium farmers. The amount of nutrients applied vary in the range of 30 to 50 kg/ha of N-P-K respectively. Large majority of bean producers in rainfed area do not apply fertilizers.	Majority of farmers apply fertilizers 3 to 4 times per year. The amount of nutrient applied vary widely among farmers, because of lack of technical guidance. Farmers normally apply low to medium level of fertilizers, 225 kg/ha N, and 108 kg/ha of P and K. Only small percentage of farmers make soil analysis before planting banana.
Irrigation	Inadequate management of on-farm irrigation and lack of drainage systems have caused problems such as elevation of freatic water level, salinization of some areas that have been used for rice production.	Majority of farmers make inadequate on-farm water management, and this have caused soil erosion in important areas. Almost all bean farmers apply water by border stripe flooding method. About 90 % farmers irrigate at interval between 10 to 15 days.	On-farm water management is inadequate. Majority of farmers apply excessive irrigation, causing loss of nutrients and drainage problems. Irrigation intervals vary from 15 to 30 days depending on water availability. Water is apply mainly in border strips flooding method
Insect Control	Insect attack is a main problem for majority of rice farmers. Main insects are Stink bug, Steam boer, and Grasshopper. 80 % of farmers make 3 to 4 applications of chemicals for insect control. Amount of insecticide applied vary widely among farmers. IPM is not been implemented by rice farmers for reducing losses caused by insects.	Large incidence of insects (specially "White fly" Bemisia tabaci) is one of the main problems affecting bean production. Majority of farmers make 3 to 4 applications of insecticides. Majority of bean producers do not know the best insecticides, and the recommended amount, and best time of application. IPM is not been implemented extensively by bean farmers.	Main insects problem in the study area are "Cosmopolites" and "Trips". Majority of plantain and banana farmers within the study area do not make adequate insect control. Nematod are also considered important problem, but most farmers do not control it.
Disease Control	Main rice diseases are Blast, Stem rot and Brown spot. Majority of farmers make 2 to 3 applications of fungicides. The products mostly used are Zinc oxides, Dithane and Antracol. The dosage of fungicides vary greatly among farmers depending on the product used (1.3 to 3 lit/ha or kg/ha).	Many of the diseases problems are related to the large incidence of insects which transmit the diseases. Among the main diseases are Virus, Rust, Antracnosis, Mildiu, and various Bacterial diseases. Most farmers use different types of fungicides for disease control.	Because of the dry climate of the area, diseases are less spread compared to the North part of the country. Majority of plantain and banana farmers within the study area do not make control of diseases.
Weed Control	Main weed species affecting rice production are Sagitaria sp, Cyperus sp, Cynodon sp, and Imperata sp. About half of rice farmers make weed control using only herbicides and the other have use a combination of herbicides and manual weeding. Majority of rice farmers make weed control twice per season.	Almost all small and medium size farmers, and majority of large farmers make weed control manually using hoes. About 25 % of large farmers use a combination of herbicides and manual control of weeds.	Weed control is made 3 to 4 times per year. Majority of farmers in the study area make weed control manually, while smaller percentage use herbicides for weed control.
Harvesting	About 40 % of rice farmer harvest by hand, other 40 % harvest using both combines machines and manually, while only about 20 % harvest rice using combine machine only.	Harvesting is made 75 to 90 days after planting. It is done manually by all farmers. Labor requirement vary from 5 to 14 man-day to harvest 1 ha. Small and medium farmers make separation of grains from the pods by passing horses on top piles of beans. Majority of large bean farmers separate grain from pods by passing tractor on top of pile of bean. Small percentage of farmers use a locally made machine for separating the grains from the pods.	Harvesting begins 8 to 10 months after planting, and thereafter is made every 20 to 30 days. Harvest and handle is made manually.

Table 4(2/2) Present Farming Practices for Main Crops in the Study Area (2/2)

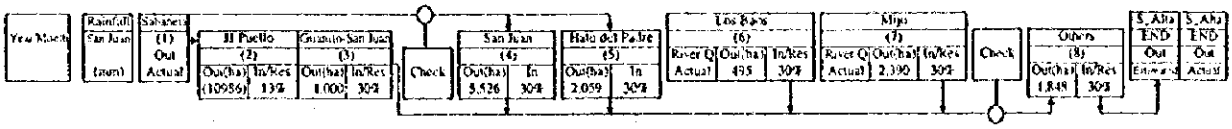
Farming Practices	Industrial Tomato	Pigeonpea	Sugar cane	Coffee
Land Preparation	Almost all tomato farmers prepare land using tractors. Because tomato need to be planted in relatively short period, the insufficiency of tractors is a bottle neck for increasing area planted to tomato in the study area	Land preparation in irrigated areas is done using both tractors and animals for plowing and harrowing, while in rainfed areas is mostly animal and manually.	Normally land preparation is done using tractors, but during the last 10 to 12 years very little land preparation have been done within the study area, due to economic constraints of the sugar corporation	All the process of land preparation for coffee planting is done manually. Land clearing and burning, and opening planting holes are the common land preparation practices
Planted Varieties	Varieties planted in the area are being changing very often in order to reduce damage by insects and virus. Most used varieties are Gem, UC82, Pepto, Napoli, and Chico	UASD, Puerto Rico, Todo el año, Barrosilat, and Kaki. Growing period of UASD is 90 days, but for other varieties is 7 month or more.	Main varieties are EROS, CR52-43, PR-980, UCW-51-65, PR10-28, RD75-10, RD75-11, B76-78, majority are old varieties.	Coffee variety extensively planted in the study area is "Typica", and in less area "Caturra" is planted
Planting Method	Tomato is planted largely by transplanting method,small percentage of farmers make direct seedling. Seedling are grown mostly in open seed bed, and small percentage is grown in trays kept in shaded areas. Planting procedures, and most other farming practices are supervised by technician from the tomato paste companies.	Planting is manually, distance between planting sites vary widely among farmers, most common distance is 1 m by 1 m, and plant 3 to 4 seeds per hole, after growing only one plant is left per hole. Amount of seeds use vary from 7 to 20 kg/ha, in average is 11 kg/ha.	For long time (about 10 years or more) most of the sugar cane area has not been replanted. Most of the area has old ratoons, which productivity has declined	Majority of coffee plantation in the study area are old. Planting of new areas or replanting of old coffee plantations is minimal
Fertilization	Fertilizers are applied twice, the first application is made shortly after transplanting and the second application is made at the beginning of flowering stage. The amount of plant nutrients applied vary between 100 to 150 kg/ha of N, and from 75 kg/ha of P and K respectively. Most farmers do not make soil analysis to know the adequate quantity of fertilizers needed.	Amount of fertilizer applied to pigeonpea is in average 15 kg/ha of N, P, and K respectively, this amount is divided in two applications.	Fertilization is made very inefficiently, the average amount of fertilizers applied to sugar cane in the study area is much lower than requirements. Average amount of plant nutrients applied are N=90 kg/ha; P=60 kg/ha, and K= 60 kg/ha, respectively.	Amount of fertilizer applied very according to the size of the coffee plantation of individual farmers. Small farmers apply very small amount of fertilizers, while large coffee farmers apply sufficient amount. Small farmers apply in average 15 kg/ha of N, and 10 kg/ha of P and K respectively.
Irrigation	Irrigation interval vary from 7 to 12 days, depending on water availability. Large number of tomato farmers do not make adequate management of on-farm water management, and this causes soil erosion and loss of plant nutrients.	Majority of area planted to pigeon pea in the study area is rainfed. In irrigated areas frequency of irrigation vary from 15 to 20 days, depending on water availability.	Management of on-farm water in the sugar cane area is very poorly done. Because ineffecient application of irrigation water, it is common to find areas with water logging and areas with water deficit in different sites of one sugar cane irrigation plot.	
Insect Control	Large incidence of insects, specially white fly is one of the main problem affecting tomato production From 1990 to 1992 the insect problem was so large that the area planted to tomato was reduced significantly. Insect control is based mainly in application of insecticides. IPM is being introduce, but still not widely applied.	Main insect problems are armyworm, green stink bug, white fly, aphid. Control of insects is made using insecticides only, majority of pigeonpea farmers apply insecticides twice. IPM is not being implemented by pigeonpea farmers in the study area.	Insects attack is not considered a very important problem in the sugar cane plantation within the study area. Stem borer (Diatrae sp.) are the most common insects. Their control inefficiently made.	Insects affecting coffee plantations in the study area include aphids, mealy bug, and hemispherical scale. Most small scale farmers do not make insect control
Disease Control	Main disease affecting tomato is the virus transmitted by "white fly". Other diseases are Rhizoctonia, Fusarium, and Alternaria.	Main diseases affecting pigeonpea in the Study area are "Antracnosis and leaf rust. Majority of farmers do not make control of pigeon pea diseases.	Diseases of importance affecting the sugar cane in the study area are "Roya" and "Carbon". Chemical control is not made. The control is made using cane varieties that are resistant to these diseases.	The main disease affecting coffee in the study area is the "brown leaf circle" caused by Cercospora sp. Majority of farmers do not make control of diseases.
Weed Control	Control of weed is made mostly manually. Some farmers use herbicides just after transplanting. Average labor used for weed control is 20 man-day/ha.	Weed control is made manually by almost all farmers. Labor used for weed control vary from 12 to 20 man-day/ha.	Weed control is made by a combination of herbicidas and manually. Labor used for weed control is about 15 man-day/ha.	Weed control in coffee area is done manually; In small coffee farms weed control is made almost completely by family labor.
Harvesting	Harvesting of tomato is done manually by all farmers. Labor used for harvesting is about 10 man-day/ha.	Majority of pigeonpea farmers harvest when grains are green (young). Harvesting is made manually. Labor used for harvesting is 8 to 10 man-day/ha	Harvesting of sugar cane is done manually. Often cane fields are burned up before harvesting in order to speed up harvesting.	Harvesting of coffee is done manually. Labor use for harvesting is between 3 to 5 man-day/ha.

Table 5 Rural Infrastructure in Census 1993

	Water Supply	Electricity Supply	Rabbish Disposal Service	Sanitary Service
	(%)	(%)	(%)	(%)
Azua (Whole Province)	(65)	(70)	(47)	(71)
Azua (Project Area)	**64**	**70**	**48**	**72**
1 Azua de Compostela	69	77	54	78
2 Guayabal	55	33	41	82
3 Las Charcas	69	81	41	73
4 Las Yayas de Biajama	47	54	41	62
5 Padre Las Casas	50	50	34	60
6 Peralta	59	69	54	67
7 Sabana Yegua	62	75	64	79
8 Tabara Arriba	76	80	51	65
9 Estebania	75	61	38	75
10 Pueblo Viejo	67	88	43	73
San Juan (Whole Province)	(56)	(56)	(34)	(66)
San Juan (Project Area)	**55**	**62**	**37**	**68**
1 San Juan De La Maguana	59	64	39	72
2 Bohechio	38	58	33	62
3 Juan De Herrera	42	60	27	56
4 Vallejuelo	52	49	42	52
Barahona (Whole Province)	(72)	(82)	(43)	(83)
Barahona (Project Area)	**76**	**90**	**53**	**84**
1 Santa Cruz de Barahona (Capital)	81	93	55	89
2 Cabral	80	86	51	72
3 Vicente Noble	47	84	47	77
4 El Penon	84	85	46	83
5 Fundacion	86	84	46	87
Bahoruco (Whole Province)	(57)	(66)	(29)	(67)
Bahoruco (Project Area)	**58**	**67**	**33**	**68**
1 Neyba	64	62	39	70
2 Galvan	34	61	21	57
3 Tamayo	64	72	43	80
4 Uvilla	57	80	18	56
La Vega (Project Area)	**57**	**73**	**49**	**83**
1 Constanza	57	73	49	83
Independencia (Project Area)	**59**	**65**	**56**	**44**
1 Mella	67	87	28	80
2 Cristobal	55	55	69	25
Total (Project Area)	**62**	**71**	**44**	**73**
National Average	**67**	**82**	**56**	**88**

Table 6 Water Balance Simulation by Irrigation Block --- San Juan Block

Present condition (without project)

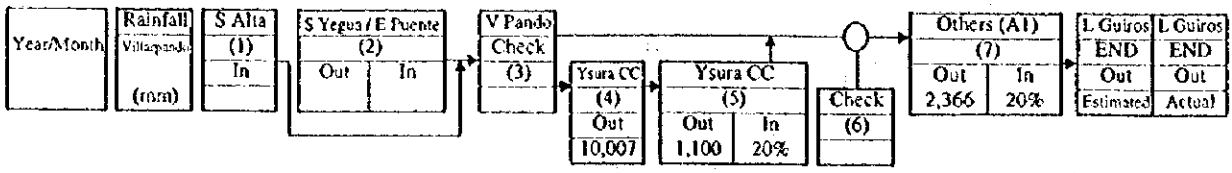


	(unit)	(mm)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)
1981		1269.8	341.3	105.3	74.3	27.8	54.8	258.7	94.1	28.2	32.7	9.8	27.6	10.7	17.8	214.7	65.1	169.1	733.2	42.1	703.7	703.7	758.8
1982		733.2	313.2	104.3	70.6	28.1	51.0	248.4	90.7	27.2	31.2	9.3	18.4	11.1	10.1	150.9	65.1	115.3	478.8	42.1	449.3	449.3	467.1
1983		1010.1	231.6	92.7	61.3	28.0	41.7	182.6	74.7	22.4	27.0	8.1	11.0	8.0	5.4	108.7	63.0	64.6	418.4	42.1	380.0	389.8	264.2
1984		903.8	260.4	97.2	66.9	28.1	47.3	205.7	82.2	24.7	29.8	8.9	14.3	9.2	7.9	118.3	64.8	73.0	446.0	42.1	416.6	415.6	-
1985		788.5	225.9	100.8	52.5	27.8	33.1	152.9	70.8	21.2	25.0	7.5	12.7	8.3	5.8	125.9	63.0	81.6	330.6	42.1	301.1	306.7	-
1986		883.9	274.5	102.3	58.8	28.0	39.2	212.7	89.2	26.7	31.2	9.4	17.7	11.1	8.5	112.7	62.3	69.1	426.1	42.1	396.6	396.6	385.9
1987		1423.7	266.3	89.6	80.9	28.1	61.3	233.6	84.1	25.2	29.6	8.9	11.7	9.0	5.4	131.9	54.6	71.6	547.1	42.1	517.6	518.3	384.6
1988		1015.9	271.6	92.0	71.0	27.5	51.8	225.1	79.0	23.7	27.1	8.1	14.6	10.4	7.3	133.3	64.9	87.9	501.2	42.1	471.7	471.7	457.4
1989		1030.2	245.7	94.8	74.3	27.6	55.0	201.6	73.2	21.9	26.0	7.8	17.1	10.4	9.8	159.9	63.7	115.3	534.3	42.1	504.8	506.3	463.2
1990		905.0	244.8	85.8	64.8	23.7	46.8	201.4	64.7	19.4	23.2	7.0	24.9	8.5	18.9	114.3	47.1	62.3	457.5	42.1	428.0	446.0	413.3
1991		512.3	238.5	102.8	49.7	28.0	30.1	153.8	77.6	23.3	28.1	8.4	10.0	8.4	4.1	128.0	64.9	82.6	272.7	42.1	248.2	250.7	250.2
1992		1267.9	264.6	101.0	72.0	28.1	52.3	223.4	93.3	28.0	32.1	9.6	4.7	3.6	1.8	133.4	59.5	91.7	548.9	42.1	519.5	520.2	625.3
1993		968.5	284.6	105.6	80.0	28.1	60.3	224.5	94.3	28.3	32.7	9.8	21.8	10.1	14.8	138.2	64.3	93.2	508.5	42.1	479.0	479.0	-
1994		664.6	211.3	106.1	51.7	27.9	32.1	130.9	75.4	22.6	26.9	8.1	28.6	11.3	20.7	118.1	63.9	73.4	300.8	42.1	271.4	276.2	-
Mean		934.1	262.5	98.6	66.3	27.8	46.9	206.5	81.9	24.5	28.8	8.6	16.8	9.5	9.9	135.6	61.9	89.3	454.9	42.1	435.5	437.9	-

Note: MCM: Million cubic meter
Out: Water extraction from the source (irrigation area in hectare in the above)
In: Return flow to the source (return flow rate in percent in the above)
In/Res.: Return flow, inflow from the residual catchment and the remaining flow to the downstream
Actual: Actual discharge in the records
Estimated: Estimated discharge by the simulation

Table 7 **Water Balance Simulation by Irrigation Block --- Azua Block**

Present condition (without project)

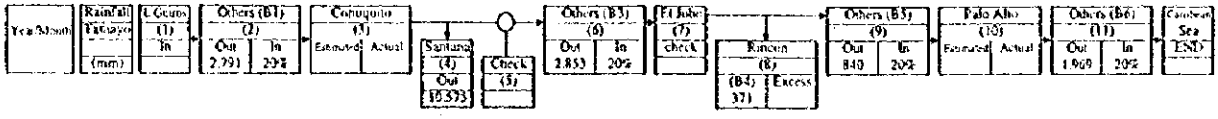


	(unit	(mm)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)
1981		584.3	758.8	729.6	980.1	1739.0	278.5	21.2	4.2	1483.2	45.7	9.1	1446.6	-
1982		415.2	467.1	769.4	867.1	1334.3	278.5	21.2	4.2	1077.8	45.7	9.1	1041.2	-
1983		665.6	284.2	629.6	-	909.0	278.5	21.2	4.2	657.3	45.7	9.1	620.7	-
1984		409.1	412.2	404.9	-	838.7	272.8	21.2	4.2	591.4	45.7	9.1	554.8	-
1985		444.6	366.7	555.9	-	854.4	278.5	21.2	4.2	598.3	45.7	9.1	561.7	-
1986		475.2	385.9	588.8	-	1027.2	278.5	21.2	4.2	771.9	45.7	9.1	735.3	718.0
1987		584.4	384.6	502.1	-	818.4	278.5	21.2	4.2	564.0	45.7	9.1	527.4	633.0
1988		551.2	497.4	515.8	-	1119.3	278.5	21.2	4.2	866.7	45.7	9.1	830.1	867.1
1989		746.5	463.2	813.4	-	1205.3	278.5	21.2	4.2	955.6	45.7	9.1	919.1	920.7
1990		514.9	410.3	421.8	-	832.1	266.8	21.2	4.2	594.7	45.7	9.1	558.2	647.0
1991		447.1	280.2	705.0	-	996.2	278.5	21.2	4.2	751.1	45.7	9.1	714.5	-
1992		313.1	625.3	575.2	-	1164.8	277.5	21.2	4.2	915.3	45.7	9.1	878.8	-
1993		617.3	440.5	832.8	-	1173.2	278.5	21.2	4.2	921.6	45.7	9.1	885.0	-
1994		670.6	255.5	473.4	468.7	724.2	278.5	21.2	4.2	474.4	45.7	9.1	437.8	-
Mean		531.4	430.9	608.4	-	1052.6	277.2	21.2	4.2	801.7	45.7	9.1	765.1	-

Note: MCM; Million cubic meter
Out; Water extraction from the source (irrigation area in hectare in the above)
In; Return flow to the source (return flow rate in percent in the above)
In/Res.; Return flow, inflow from the residual catchment and the remaining flow to the downstream
Actual; Actual discharge in the records
Estimated; Estimated discharge by the simulation

Table 8 Water Balance Simulation by Irrigation Block --- Barahona Block

Present condition (without project)



	(mm)	(mm)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)
1981	461.7	1445.6	109.4	21.9	1514.9	-	381.9	1133.0	111.8	22.4	1043.5	13.7	-	48.7	9.7	1011.0	934.4	39.4	15.8	947.5
1982	271.5	1041.2	109.4	21.9	1034.3	-	397.3	637.1	111.8	22.4	547.6	13.7	-	49.4	9.9	504.5	381.8	85.0	17.0	436.5
1983	342.8	620.7	109.4	21.9	522.4	-	280.9	291.6	111.8	22.4	202.1	13.7	-	49.4	9.9	154.5	-	73.9	14.8	95.3
1984	248.7	554.8	109.4	21.9	503.9	543.6	251.9	251.9	105.8	21.2	167.3	13.3	-	44.5	8.9	122.9	181.7	59.3	11.9	75.5
1985	655.3	561.7	109.4	21.9	558.6	412.8	276.1	282.5	111.8	22.4	193.9	13.7	-	48.1	9.6	148.9	218.1	68.7	13.7	93.9
1986	348.8	718.0	109.4	21.9	791.0	-	348.8	442.2	111.8	22.4	352.8	13.7	-	49.4	9.9	313.8	422.0	85.0	17.0	245.8
1987	476.9	633.0	109.4	21.9	618.3	513.6	289.8	328.5	111.8	22.4	239.0	13.7	-	45.2	9.0	197.3	-	60.6	12.1	148.8
1988	254.4	867.1	109.4	21.9	871.1	867.4	370.4	500.7	111.8	22.4	418.2	13.7	-	49.4	9.9	367.2	-	85.0	17.0	299.2
1989	303.6	920.7	109.4	21.9	881.4	-	383.2	498.2	111.8	22.4	408.7	13.7	-	49.4	9.9	361.6	-	85.0	17.0	293.6
1990	354.1	647.0	109.4	21.9	622.2	-	251.8	370.5	101.0	20.2	289.7	13.6	-	32.3	6.5	257.3	-	51.5	10.3	216.1
1991	857.8	703.8	109.4	21.9	658.0	666.9	320.1	337.9	111.8	22.4	248.5	13.7	-	49.4	9.9	199.8	-	80.6	16.1	135.3
1992	491.2	970.4	109.4	21.9	932.9	-	344.9	588.0	105.7	21.1	503.5	13.3	-	43.7	8.7	451.7	-	66.9	13.4	408.2
1993	449.6	885.0	109.4	21.9	890.1	-	351.0	539.1	111.8	22.4	449.7	13.7	-	49.4	9.9	405.8	-	82.2	16.4	340.0
1994	557.4	437.8	109.4	21.9	454.2	-	227.1	227.1	111.8	22.4	132.7	13.7	-	46.2	9.2	96.8	-	63.3	12.7	46.2
Mean	355.6	786.3	109.4	21.9	778.8	-	319.7	459.1	110.2	22.0	371.0	13.6	-	46.8	9.4	338.8	-	73.3	14.7	270.1

Note: MCM; Million cubic meter
Out; Water extraction from the source (irrigation area in hectare in the above)
In; Return flow to the source (return flow rate in percent in the above)
In/Res.; Return flow, inflow from the residual catchment and the remaining flow to the downstream
Actual; Actual discharge in the records
Estimated; Estimated discharge by the simulation

Table 9 **Simulated Irrigation Water Supply and Sufficiency**

San Juan (without project condition)

Year		J.J.Puello		San Juan		Hato de Padre		Guanito San Jua		Mijo		Vallejuelo	
Drought/Wet		MCM	(%)	MCM	(%)	MCM	(%)	MCM	(%)	MCM	(%)	MCM	(%)
1981	+	57.9	98%	64.5	91%	22.2	96%	18.5	99%	43.3	99%	7.3	93%
1981/82		50.6	100%	32.4	98%	11.3	100%	9.5	100%	22.0	100%	3.5	45%
1982	-	58.1	98%	61.8	87%	20.6	89%	18.7	100%	43.3	99%	7.6	97%
1982/83		43.9	87%	27.3	83%	9.9	87%	9.5	100%	21.8	99%	3.1	40%
1983	+	49.5	84%	47.7	67%	17.1	74%	18.6	99%	41.3	95%	4.9	63%
1983/84		43.6	86%	28.7	87%	10.5	92%	9.5	100%	21.9	100%	3.5	45%
1984	-	48.9	83%	51.5	72%	18.6	80%	18.7	100%	43.0	98%	5.7	73%
1984/85		49.4	98%	30.1	91%	11.0	97%	9.5	100%	21.5	98%	3.2	41%
1985	-	51.2	86%	39.7	56%	14.2	61%	18.4	98%	41.6	95%	5.4	70%
1985/86		50.6	100%	33.0	100%	11.3	100%	9.5	100%	22.0	100%	2.9	38%
1986	-	55.0	93%	58.9	83%	20.4	88%	18.6	99%	40.4	92%	7.8	100%
1986/87		43.8	86%	27.4	83%	10.0	88%	9.5	100%	20.1	92%	3.3	42%
1987	+	45.4	77%	56.8	80%	19.6	85%	18.7	100%	43.3	99%	5.7	73%
1987/88		45.8	91%	28.4	86%	10.3	91%	9.5	100%	13.3	60%	3.4	44%
1988	+	46.3	78%	50.9	71%	16.9	73%	18.1	97%	43.3	99%	7.0	90%
1988/89		43.2	85%	26.5	80%	9.8	87%	9.5	100%	22.0	100%	3.5	45%
1989	+	50.3	85%	45.7	64%	15.8	69%	18.2	97%	41.9	96%	7.0	89%
1989/90		46.0	91%	28.9	88%	10.5	93%	9.5	100%	22.0	100%	3.0	39%
1990	?	37.9	64%	35.0	49%	12.4	54%	16.2	87%	30.0	69%	5.5	71%
1990/91		49.4	98%	30.5	93%	11.1	98%	9.5	100%	16.9	77%	3.5	45%
1991	-	55.3	93%	48.8	69%	17.6	76%	18.6	99%	43.3	99%	5.0	64%
1991/92		43.6	86%	27.2	82%	10.1	89%	9.5	100%	21.0	96%	2.3	29%
1992	+	55.5	94%	64.2	90%	21.8	95%	18.7	100%	38.7	88%	2.2	28%
1992/93		50.5	100%	33.0	100%	11.3	100%	9.5	100%	22.0	100%	1.7	22%
1993	+	55.3	93%	61.5	86%	21.4	93%	18.7	100%	42.4	97%	7.4	95%
1993/94		50.6	100%	33.0	100%	11.3	100%	9.5	100%	21.4	97%	3.5	45%
1994	-	55.6	94%	42.5	60%	15.6	68%	18.5	99%	42.7	98%	7.8	100%
Mean (1st)		47.0	93%	29.7	90%	10.7	94%	9.5	100%	20.6	94%	3.1	40%
Mean (2nd)		51.1	86%	51.1	72%	17.9	77%	18.4	98%	41.2	94%	6.1	78%

Note: "+"; wet year (according to probability analysis)
"-"; dry year (according to probability analysis)
"?"; data not available
1st; The first cropping (November to April)
2nd; The seconc cropping (May to October)

Table 10 **Simulated Irrigation Water Supply and Sufficiency**

Azua (without project condition)

Year		Ysura HRC		Ysura		Area A1	
Drought/Wet		(MCM)	(%)	(MCM)	(%)	(MCM)	(%)
1981	+	9.2	100%	102.4	100%	19.8	100%
1981/82		12.0	100%	154.4	100%	25.8	100%
1982	-	9.2	100%	102.4	100%	19.8	100%
1982/83		12.0	100%	154.4	100%	25.8	100%
1983	-	9.2	100%	102.4	100%	19.8	100%
1983/84		12.0	100%	148.7	96%	25.8	100%
1984	-	9.2	100%	102.4	100%	19.8	100%
1984/85		12.0	100%	154.4	100%	25.8	100%
1985	+	9.2	100%	102.4	100%	19.8	100%
1985/86		12.0	100%	154.4	100%	25.8	100%
1986	+	9.2	100%	102.4	100%	19.8	100%
1986/87		12.0	100%	154.4	100%	25.8	100%
1987	+	9.2	100%	102.4	100%	19.8	100%
1987/88		12.0	100%	154.4	100%	25.8	100%
1988	+	9.2	100%	102.4	100%	19.8	100%
1988/89		12.0	100%	154.4	100%	25.8	100%
1989	-	9.2	100%	102.4	100%	19.8	100%
1989/90		12.0	100%	154.4	100%	25.8	100%
1990	+	9.2	100%	102.4	100%	19.8	100%
1990/91		12.0	100%	154.4	100%	25.8	100%
1991	-	9.2	100%	90.7	89%	19.8	100%
1991/92		12.0	100%	154.4	100%	25.8	100%
1992	+	9.2	100%	102.4	100%	19.8	100%
1992/93		12.0	100%	153.3	99%	25.8	100%
1993	+	9.2	100%	102.4	100%	19.8	100%
1993/94		12.0	100%	154.4	100%	25.8	100%
1994	+	9.2	100%	102.4	100%	19.8	100%
Mean (1st)		12.0	100%	153.8	100%	25.8	100%
Mean (2nd)		9.2	100%	101.5	99%	19.8	100%

Note: "+"; wet year (according to probability analysis)
"-"; dry year (according to probability analysis)
"?"; data not available
1st; The first cropping (November to April)
2nd; The seconc cropping (May to October)
A1; Irrigation area between Villarpando and Los Guiros

Table 11 **Simulated Irrigation Water Supply and Sufficiency**

Barahona (without project condition)

Year		Area B1		Area B2		Area B3		Area B4		Area B5		Area B6	
Drought/Wet		MCM	(%)	MCM	(%)	MCM	(%)	MCM	(%)	MCM	(%)	MCM	(%)
1981	+	54.5	100%	227.6	100%	55.4	100%	6.8	100%	24.8	100%	42.7	92%
1981/82		54.9	100%	193.5	87%	56.4	100%	6.9	100%	24.6	100%	42.3	90%
1982	-	54.5	100%	215.9	95%	55.4	100%	6.8	100%	24.8	100%	42.7	92%
1982/83		54.9	100%	134.7	60%	56.4	100%	6.9	100%	24.6	100%	37.6	80%
1983		54.5	100%	151.8	67%	55.4	100%	6.8	100%	24.8	100%	36.3	78%
1983/84		54.9	100%	106.9	48%	50.5	90%	6.5	95%	20.2	82%	26.1	56%
1984	-	54.5	100%	140.4	62%	55.4	100%	6.8	100%	24.3	98%	33.2	71%
1984/85		54.9	100%	135.0	61%	56.4	100%	6.9	100%	24.6	100%	37.3	80%
1985	+	54.5	100%	124.0	54%	55.4	100%	6.8	100%	23.5	95%	31.4	67%
1985/86		54.9	100%	189.8	85%	56.4	100%	6.9	100%	24.6	100%	42.3	90%
1986		54.5	100%	184.8	81%	55.4	100%	6.8	100%	24.8	100%	42.7	92%
1986/87		54.9	100%	106.7	48%	56.4	100%	6.9	100%	22.3	91%	26.0	55%
1987	+	54.5	100%	157.7	69%	55.4	100%	6.8	100%	22.9	92%	34.7	74%
1987/88		54.9	100%	172.0	77%	56.4	100%	6.9	100%	24.6	100%	42.3	90%
1988	-	54.5	100%	204.7	90%	55.4	100%	6.8	100%	24.8	100%	42.7	92%
1988/89		54.9	100%	174.3	78%	56.4	100%	6.9	100%	24.6	100%	42.3	90%
1989	-	54.5	100%	216.6	95%	55.4	100%	6.8	100%	24.8	100%	42.7	92%
1989/90		54.9	100%	129.6	58%	56.4	100%	6.9	100%	19.8	81%	28.8	62%
1990		54.5	100%	117.4	52%	44.5	80%	6.7	99%	12.4	50%	22.6	49%
1990/91		54.9	100%	149.2	67%	56.4	100%	6.9	100%	24.6	100%	38.0	81%
1991	-	54.5	100%	181.3	80%	55.4	100%	6.8	100%	24.8	100%	42.7	92%
1991/92		54.9	100%	106.5	48%	50.3	89%	6.5	95%	18.9	77%	24.4	52%
1992	+	54.5	100%	227.6	100%	55.4	100%	6.8	100%	24.8	100%	42.7	92%
1992/93		54.9	100%	158.1	71%	56.4	100%	6.9	100%	24.6	100%	39.5	84%
1993	+	54.5	100%	208.0	91%	55.4	100%	6.8	100%	24.8	100%	42.7	92%
1993/94		54.9	100%	119.7	54%	56.4	100%	6.9	100%	24.3	99%	32.2	69%
1994	+	54.5	100%	119.1	52%	55.4	100%	6.8	100%	21.9	88%	31.1	67%
Mean (1st)		54.9	100%	144.3	65%	55.5	98%	6.8	99%	23.3	95%	35.3	75%
Mean (2nd)		54.5	100%	173.0	76%	54.6	98%	6.8	100%	23.4	94%	37.5	81%

Note: "+"; wet year (according to probability analysis)

"-"; dry year (according to probability analysis)

"?"; data not available

1st; The first cropping (November to April)

2nd; The seconc cropping (May to October)

B1; Irrigation area between Los Guiros and Santana Headworks

B2; Irrigation area of Santana

B3; Irrigation area between Santana Headworks and Tomate-Mena Drain

B4; Irrigation area of Tomate-Mena

B5; Irrigation area between Tomate-Mena Drain and Palo Alto

B6; Irrigation area between Palo Alto and Carribean Sea

Table 12(1/2) Recommended Farming Practices for Main Crops in the Study Area (1/2)

Farming Practices	Rice	Red Bean	Plantain & Banana
Land Preparation	Adequate land preparation help in controlling weeds, incorporate fertilizers in the soil, reduce deep percolation of water, and facilitate growth of roots. Make deep plowing, harrowing, paddling and land surface leveling.	Adequate land preparation is important in order to obtain high yield of bean. First plowing at 25 cm depth, and two horrowing at intervals of 15 days to finely break the soil agregates.	One deep plowing and two harrowing are recommended. Make planting holes at distance of 2.5 m by 2.5 m in triangular alignment to attain a planting density of at least 1,600 plants/ha. Field drainage should be adequately provided
Recommended Varieties	Prosequisa-4 which has a growing period of 120 days and yield of 4.5 ton/ha can be attained. Other varieties recommended are Isa-40, and Jima-58.	The most recommended variety is PC-50, which is tolerant to several diseases, and can produce higher yield in the area. Growing cycle is 80 to 90 days. Yield of 1.5 ton/ha can be attained. Other varieties are CIAS-95, José Beta, and Pompadour Checa.	Recommended varieties are "Macho por Hembra", "Barahonero". Banana varieties are "Cavendish", "Media mata", and "Gross Michel"
Planting Method	Use certified seeds. Direct field seeding is generally used in San Juan area. The amount of seeds recommended is 160 kg/ha. Pre-germinate seeds by soaking in water for about 24 hours, and then exposing the soaked seeds in open air for 3 days. Planting rice from May to June. For direct seeding method it is very important to make adequate leveling of land surface.	Plant as early as possible within the period fixed by SEA's regulation, from beginning Nov. to mid Dec. Planting distance 50 cm between rows and 10 cm between plants. Quantity of seeds is 110 kg/ha. Borders stripes should be 2.5 m width and 25 m long in order to make better control of irrigation water.	The use of seedlings grown by tissue culture are recommended to attain pest and disease free planting material; In case of using suckers from other field for planting material, it is necessary to make adequate desinfection; Recommended planting density is 1600 plant/ha. Adequate illumination is necessary for attaining good yield. Fertilizers and insecticides are located on the bottom of the planting holes at the moment of planting.
Fertilization	Soil analysis are necessary. As general guideline the amount of fertilizer recommended is N=180 kg/ha; P=90 kg/ha, and K=90 kg/ha. Do not use nitrate fertilizer on submerged rice field, only ammonium type of nitrogen fertilizer should be used.	Soil analysis should be made to know the specific requirement of fertilizer for each soil series. General recommendation of fertilizer is N= 75 kg/ha; P=95 kg/ha, and K= 40 kg/ha. Apply fertilizers at the moment of planting.	Plantain and Banana require good application of nitrogen ad potassium fertilizers. The amount of nutrient fertilizers recommended are N= 250 kg/ha; P=110 kg/ha, and K= 150 kg/ha; Divide the total amount into 2 or 3 applications per year. Soil analysis is recommended to determine specific requirement of nutrients.
Irrigation	Good supply and management of irrigation water is necessary for attaining high yields of rice. A critical period of water requirement is from flowering up to grain filling. Irrigation water have several functions in rice production, such as weed control diseases control, control of soil temperature, and improvement of chemical condition of soil. Adequate land preparation, including surface leveling is essential for good management of irrigation. Rice field should be drained 25 days after grain filling.	It is necessary to make adequate on-farm management of irrigation water to avoid water lodging and loss of fertilizers due to excessive application of water. The critical period for water requirement are (1) at the moment of planting to ensure germination; (2) At flowering; and (3) grain formation.	Irrigation is required at least once or twice every month. Adequate on-farm water management should be implemented to avoid excessive irrigation, loss of nutrients and drainage problems. Farm drainage should be provided
Insect Control	Insect attack is a main problem for majority of rice farmers. Main insects are Stink bug, Steam borer, and Grasshopper. Introduction of Integrated Pest management (IPM) is recommended in order to make an effective and economic control o insects. Application of insecticides, such as Karate at rate of 3 lit/ha, divided in two or three applications, are recommended for insect control.	Introduction of Integrated Pest Management (IPM) is necessary for adequate control of insects. For White fly, insecticides Monocrotophos at rate of 1.5 % at 14, 21 and 25 days after planting. For control of Empoasca apply Carbaryl at rate of 1 gr per liter; Monocrotophos or Dimetoate at 1.5 ml/lit. Adequate control of weeds help to reduce insects population.	Main insects problem in the study area are "Cosmopolites" and "Trips". Nematode are also considered important problem. Their control can be partially made by introduction of IPM; Installation of simple traps are recommended for control of "Cosmopolites" insects. Insecticides such as "Sistemin" and "Furadan" are recommended at rate of 2 lit/ha.
Disease Control	Main rice diseases are Blast, Stem rot and Brown spot. Introduction of IPM is recommended, including use of resistant varieties, certified seeds, good management of irrigation, adequate level of fertilization, weed and insect control, etc. Combination of IPM with application of fungicides based on Zinc oxides, Dithane or Antracol depending on the disease, at rate of 1 kg/ha could make an adequate and economic control of rice diseases.	First of all, the use of a variety such as PC-50 that is resistant to several plant diseases. Second, introduce IPM practices; Several diseases are transmited by insects, therefore insect control is important in reducing the incidence of diseases. Application of fungicides at rate of 1 kg/ha divided in several applications.	Foliar diseases are not major problem for plantain and banana in the Study area, but roots diseases can become important. Application of fungicide, such as "Dithane" at rate of 5 kg/ha is recommended. IPM, including good fertilization, control of insect, control of weeds, and adequate water management will help to deduce incidence of roots diseases on plantain and banana.
Weed Control	Main weed species affecting rice production are Sagitaria sp, Cyperus sp, Cynodon sp, and Imperata sp. A combination of herbicides (Propanil at rate o 1.5 lit/ha), mechanical and manual methods for control of weeds is recommended. Adequate management of irrigation water help in the control of weeds.	Leaving an interval of about 15 days between plowing and harrowing help in control of weeds. Do not let weeds plants to produce seeds. Do not make weed control during the flowering stage. Mechanical control of weeds, using either tractor of animal traction is recommended to reduce costs and improve soil condition.	Weed control is very important from planting up to total coverage of soil by plantain and banana made 3 to 4 times per year. At these stage, a combined control of weeds by mechanical means and use of herbicides is recommended. After the plantation are grown and cover the land, weed control should be manually using machete.
Harvesting	About 40 % of rice farmer harvest by hand, other 40 % harvest using both combines machines and manually, while only about 20 % harvest rice using combine machine only. Rice harvester used in San Juan area are large type combine that can not be used in small farms and are difficult to maintain. The introduction of medium size rice harvesters would help to reduce cost of harvesting in small farms.	Harvest 85 to 90 days after planting. Wait until bean reaches it maturity, indicated by yellowing and dropping of leaves. Harvesting is recommended to be done only on early morning, to avoid opening of pods and drop of grains.	Harvesting begins 8 to 10 months after planting, and thereafter is made every 20 to 30 days. Harvest and handle is made manually. Labor requirement for harvesting one ha is about 21 man-day per year.

Sources of Recommendations: Rice: (1) Rice Production Bulletin, SEA, 1988; (2) Tropical Agriculture Compendium, BCA 1986; (3) Production Costs, Agricultural Bank 1993.

Red Bean: (1) Several Bulletins on Bean Production, SEA Proyecto Titulo XII, and FDA, 1993; (2) Tropical Agriculture Compendium, BCA 1986;

(3) Handbook on Tropical Legume Cultivation, AICAF, 1995.

Plantain & Banana: (1) Tropical Agriculture Compendium, BCA 1986; (2) Tropical Crops, J. W. Purseglove, 1972; (3) Production Costs, Agricultural Bank 1993;

(4) Notes of conversation with CIAZA's specialist.

Table 12(2/2) Recommended Farming Practices for Main Crops in the Study Area (2/2)

Farming Practices	Industrial Tomato	Pigeonpea	Sugar cane	Coffee
Land Preparation	Before plowing soil surface should be clean out of leftover from previous crop and grown weeds. Plow at depth between 20 to 30 cm. If hard pan exist, depth of plowing should be 40 to 50 cm. Harrowing is recommended at 15 days interval.	Plow at depth of 15 cm and harrowing once. Prepare ridges to facilitate irrigation and better condition for root growth.	Deep chiseling is recommended to favor vertical movement of water and leaching of salts. Remove stems of previous cane plants. Then, plowing 25 cm deep, followed by harrowing. Make ridges 20 cm deep and separated at 150 cm. Land leveling and ridging.	Land clearing and opening of planting holes are the needed land preparation practices. This are done manually.
Recommended Varieties	Recommended varieties are: Pepto -98, UC 82, Napolis VF, and hybrids Gem Star, Gem Pride, Gem Pear, 960, and 1001.	A new dwarf variety introduced from India. This variety was tested in CIAZA and gave excellent results of high yield in short growing period. Other varieties are UASD, Puerto Rico that are of short growing period and high yielding.	Recommended varieties are B70-89, B76-56, B76-78, B76-196, and BR62-02	"Caturra" is coffee variety recommended to be planted with project condition
Planting Method	Transplanting method is largely used. Seedling grown in trays kept in shaded areas (spellings) are recommended, in order to reduce damages from insects. Seedling are ready for transplanting 15 to 20 days after planting the seeds. Transplant at distance of 120 cm between rows and 25 cm between plants. Roots of seedlings should be placed about 5 cm deep.	The dwarf variety from India is planted at high population density (80 cm between rows and 20 cm between plants. Amount of seeds required is about 20kg/ha. Seed should be planted at depth of 4 to 5 cm.	Sugar cane is propagated by stem cuttings of immature canes known as "seed-pieces" or "setts". The cane used for "seeds" should be grown specially for this purpose free from insects and disease damages; the "seeds should be between 8 to 10 months old. "Seed" pieces should be chosen from the upper 1/3 (younger part) of the cane, and should have 2 to 3 buds. The "seed" pieces are planted with 25 % overlapping; Planting depth is about 7.5 cm. About 20,000 "seed" pieces are required to plant 1 ha of cane.	Majority of coffee plantation in the study area are old. Planting of new areas or replanting of old coffee plantations is minimal. Seedlings grown in plastic bags are planted to the field at age between 6 to 10 months old Planting distance is 2.5m by 2.5 m for a population density of 1,600 plants per ha. Planting hole should be made 30 cm in all directions (30cm by 30 cm by 30 cm), holes should be refilled with top soil mixed with organic matter.
Fertilization	Tomato requires relatively large amount of fertilizers in order to produce high yield. At the beginning of growin stage the requirement are lower than at fruit formation stage. The total amount of nutrient recommended are N= 200 kg/ha; P= 90 kg/ha , and K= 150 kg/ha; Apply half of fertilizers at transplanting and the other half before flowering. Make soil analysis to know the exact quantity of fertilizers needed for each soil type.	Pigeonpea do not require high quantity of fertilizers. In many cases the soil can provide the amount of nutrient needed by pigeonpea; In soil of the Study are which are low in nitrogen the amount of fertilizers recommended as general guidance are N=45 kg/ha; P= 45 kg/ha, and K= 30 kg/ha.	Detailed soil analysis and field trial to determine the actual requirement of fertilizers for cane. As general guide N= 250 kg/ha; P=80 kg/ha, and K=300 kg/ha. Phosphate fertilizer should be mixed in the soil at plating time. Nitrogen should be split in two applications, first two weeks after planting, and the second about two months after planting.	Amount of fertilizer are indicated as a general guideline. Soil analysis and trial of different levels of fertilization should be undertaken in the proposed pilot areas in order to determine most accurate recommendations for fertilizer levels. The amount of fertilizer recommended vary with the growing stage of coffee. At development, apply about N=195 kg/ha, P=120 kg/ha, and K= 60 kg/ha. Apply fertilizer in circle around each coffee tree.
Irrigation	Irrigation is essential to attain the target yield. Deficit or excess of soil humidity will cause reduction of yield. Soil humidity should be kept at 70 to 80 % of field capacity. Adequate on-farm water management help reduce incidence of diseases.	Water requirement of recommended varieties are relatively low because the short growing period of these varieties. Irrigation should be provided at intervals of 12 to 15 days.	Adequate irrigation and drainage practice is necessary to attain the target yield of sugar cane. Irrigation water must infiltrate to wet the entire root depth. During the 3 months irrigation intervals should be 2 weeks, after that, intervals are 3 weeks	RAINFED
Insect Control	Large incidence of insects, specially white fly is one of the main problem affecting tomato production. Introduction of IPM is strongly recommended to help in controlling insects. Application of insecticides such as "Nuvacron" are recommended at rate of 6 lits/ha divided in several applications, according to insect population.	Main insect problems are armyworm, green stink bug, white fly, aphid. Control of insects should be based on combination of IPM and use of insecticides, such as "Karate" at rate of 1 lit/ha is recommended. Application of insecticides should be suspended 15 days before harvest of the green pods	Insects attack is not considered a very important problem in the sugar cane plantation within the study area. Stem borer (Diatrae sp.) are the most common insects. Their control is made by application of insecticides at rate of 3 lits/ha, divided in 3 or 4 applications. Introduction of IPM, including use of varieties that are resistant to insects and disease attack.	Insects affecting coffee plantations in the study area include aphids, mealy bug, and hemispherical scale. The introduction of IPM combined with application of systemic insecticides at rate of 2 lit/ha are recommended
Disease Control	Main disease affecting tomato is the virus transmitted by "white fly". Other diseases are Rhizoctonia, Fusarium, and Alternaria. It is important to control insects, specially white fly in order to prevent the wide spread of diseases. IPM is recommended to reduce incidence of diseases; Important measures include planting date, use of tolerant varieties, planting healthy seedlings, etc.; Fungicides such as "Dithane at rate of 8kg/ha divided in several applications.	Main diseases affecting pigeonpea in the Study area are "Antracnosis and leaf rust, and some virus diseases. In general the use of fungicide seems to be economically not justified; Application of IPM will reduce diseases problems.	Diseases of importance affecting the sugar cane in the study area are "Roya" and "Carbon". The control is made using cane varieties that are resistant to these diseases.	The main disease affecting coffee in the study area is the "brown leaf circle" caused by Cercospora sp. IPM practices and application of fungicides such as "Benlate" and "Cupravit" at rate of 8 kg/ha and 3 kg/ha respectively.
Weed Control	Effective control of weeds, both inside and around of tomato fields, is one important component of IPM. Control of weed is made mostly manually; average labor used for weed control is 20 man-day/ha.	Pigeonpea should be kept free from weeds during the early growth stages to avoid significant reduction of yield. Weed control can be made mechanically or manually.	Weed control is made by a combination of herbicides and manually. Labor used for weed control is about 15 man-day/ha.	Coffee fields must be kept free from weeds infection in order to avoid reduction of yield. Weed control in coffee area is done manually.
Harvesting	Harvesting of tomato is done manually by all farmers. Labor used for harvesting is about 10 man-day/ha.	Majority of pigeonpea farmers harvest when grains are green (young). Harvesting is made manually. Labor used for harvesting is 8 to 10 man-day/ha	Harvesting of sugar cane is done manually. Burning-up before harvesting should be reduced or eliminated. The labor is about 5 man-day/ha.	Care harvesting and post-harvest handling of coffee is necessary to attain high quality grains. Coffee bean of different maturity condition should no be mixed. Harvesting is done manually. Labor use for harvesting is between 3 to 5 man-day/ha.

Source of recommendations:

Tomato: (1) Tomato Farming. Bulletin 19 of FDA, 1993; (2) Production Costs, Agricultural Bank 1992; (3) Notes from conversation with CIAZA's specialist and manager of tomato paste mill.

Pigeonpea: (1) Commercial Production of Pigeonpea, FDA, 1990; (2) Handbook of Tropical Legumes Cultivation, AICAF, 1995; (3) Notes from conversation with CIAZA's specialist.

Sugar cane: (1) Study for Rehabilitation of Irrigation and Drainage system of Barahona sugar Mill, World Bank-CEA, 1986; (2) Annual Performance Report, CEA, 1997.

(3) Notes and printout provided by administration of Barahona sugar Mill. (4) Tropical Agriculture Compendium, IICA, 1989.

Coffee: (1) Coffee Development Plan, SEA 1997; (2) Tropical Agriculture Compendium, IICA 1989; (3) Coffee, by Gordon Wrigley, Tropical Agriculture Series, 1986.

Table 13 Anticipated Production of Major Crops With Projects Implementation

Crops	Present/Without Project			With Project			Projects
	Area Planted (ha)	Yield (ton/ha)	Production (ton)	Area Planted (ha)	Yield (ton/ha)	Production (ton)	Incremental Benefit of Production (ton)
(1) AZUA Irrigation District							
Plantain	4,048	18	72,860	5,013	23	115,300	42,440
Banana	791	26	20,570	791	36	28,480	7,910
Papaya	144	48	6,910	188	65	12,220	5,310
Ind. Tomato	3,170	25	79,250	3,731	30	111,930	32,680
Corn	970	2	1,940	1,203	2.8	3,370	1,430
Sorghum	862	3.5	3,020	1,068	4.5	4,810	1,790
Cassava	526	9	4,730	659	12	7,910	3,180
Pepper	83	15	1,250	98	18	1,760	510
Pigeon pea	263	1.7	450	366	3	1,100	650
Rice	325	2.5	810	325	4.5	1,460	650
Bean	929	0.9	840	1,329	1.5	1,990	1,150
Sweet potato	149	12	1,790	188	17	3,200	1,410
Eggplant	75	16	1,200	90	20	1,800	600
Melon	35	35	1,230	41	40	1,640	410
Avocado	10	10	100	12	12	140	40
Mango	25	12	300	30	16	480	180
Onion	75	11	830	88	13	1,140	310
Okra	80	12	960	94	15	1,410	450
Tobacco	37	1.6	60	53	2.2	120	60
(2) San Juan Irrigation District							
Bens	9049	1.1	9,950	14517	1.5	21,780	11,830
Rice	7973	3	23,920	7973	4.5	35,880	11,960
Sweet potato	2087	13	27,130	4491	17	76,350	49,220
Corn	1015	2	2,030	2244	2.8	6,280	4,250
Sorghum	735	3.5	2,570	1742	4.5	7,840	5,270
plantain	214	17	3,640	390	23	8,970	5,330
Pigeon pea	320	1.9	610	462	3	1,390	780
Banana	164	24	3,940	164	36	5,900	1,960
Cassava	327	10	3,270	427	12	5,120	1,850
Eggplant	163	17	2,770	214	20	4,280	1,510
Pepper	139	16	2,220	182	18	3,280	1,060
Melon	75	35	2,630	97	40	3,880	1,250
Papaya	218	52	11,340	279	65	18,140	6,800
Orange	25	15	380	32	20	640	260
Mango	20	12	240	25	16	400	160
Avocado	10	10	100	12	12	140	40
Onion	100	11	1,100	171	14	2,390	1,290
Coconut	25	6	150	32	8	260	110
(3) Yaque del Sur Irrigation District							
Plantain	5,655	18	101,790	7,223	23	166,129	64,340
Banana	1,419	26	36,890	1,419	36	51,084	14,190
Coconut	265	6	1,590	338	8	2,704	1,110
Corn	54	1.8	100	70	2.8	196	100
Sorghum	44	3.3	150	45	4.5	203	50
Rice	33	2.2	70	33	4.5	149	80
Bean	62	0.9	60	80	1.5	120	60
Pigeion pea	16	1.3	20	22	3	66	50
Cassava	257	8	2,060	322	12	3,864	1,800
Sweet potato	18	12	220	23	17	391	170
Tomato	61	24	1,460	78	30	2,340	880
Sugar Cane	1,140	30	34,200	760	115	87,400	53,200
(4) Lago Enriquillo Irrigation District							
Sugar cane	7660	30	229,800	3240	115	372,600	142,800
Plantain	700	18	12,600	3401	23	78,223	65,620
Banana	21	26	550	21	36	756	210
Rice	45	2.2	100	45	4.5	203	100
Bean	123	0.9	110	1075	1.5	1,613	1,500
Corn	156	1.8	280	1427	2.8	3,996	3,720
Sorghum	56	3.3	180	1327	4.5	5,972	5,790
Cassava	455	8	3,640	4014	12	48,168	44,530
Sweet potato	40	12	480	294	17	4,998	4,520
Eggplant	10	15	150	328	20	6,560	6,410
Tomato	94	24	2,260	1048	30	31,440	29,180
Pigeon pea	90	1.3	120	90	3	270	150

Table 14 Preliminary Comparison Study of Mini-hydropower Scheme

		Santana		J. J. Puello		Magueyal
		Original Plan	Present Study	Original Plan	Present Study	
Designed Discharge for Generator	(m3/sec)	18	11	8.4	6.5	8
Effective Head	(m)	6	6	58	58	40
Generated Output (Installtion capacity	(kW)	940	574	3,900	3,000	2,600
Annual Possible Power Generation	(GWh)	6.9	4.1	28	21	22
Direct Construction Cost	(million RD$)	18.5 (in 1989)		118.8 (in 1994)		
Direct Construction Cost	(million RD$)	68.45 (present value)	40.33	237.6 (present value)	190	156 (JICA Study)
Cost per power (50 years)	(RD$/kWh)	0.26	0.27	0.23	0.24	0.19

Table 15 Irrigation Water Demand

Unit : MCM

Irrigation Zone & System	Nov.	Dec.	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
San Juan Zone													
JJ Puello	4.37	11.87	19.01	10.18	2.80	2.43	7.06	13.75	11.72	10.24	6.16	4.06	103.67
San Juan	3.02	10.68	18.56	10.53	3.14	1.54	6.80	13.84	13.53	11.33	7.77	4.63	105.38
Hato del Padre	0.59	2.36	4.35	2.52	0.94	0.62	2.26	4.22	3.91	3.53	2.58	1.47	29.36
Guanito S. Juan	0.44	1.76	3.19	1.63	0.23	2.03	3.07	4.72	3.90	2.72	1.29	0.47	25.44
Other small system*	0.72	2.83	5.20	2.90	0.86	0.56	2.75	5.24	4.95	4.36	3.13	1.79	35.28
Mijo	2.68	3.51	5.20	3.07	1.29	1.09	3.19	5.80	7.17	5.56	4.20	3.08	45.86
Vallejuelo	0.90	0.96	0.40	0.14	0.17	0.26	0.24	0.51	0.48	0.28	0.11	0.08	4.51
Total	11.83	33.01	55.52	30.81	9.27	8.27	25.12	47.57	45.18	37.74	25.14	15.51	344.98
Azua Zone													
Area from YSURA H.R.	1.46	2.16	2.69	2.25	1.81	1.65	1.33	1.83	2.60	1.94	1.32	0.85	21.89
Amiama Gomez & Biafara	2.80	3.38	3.59	3.84	4.28	3.95	3.01	3.82	5.06	3.72	2.49	1.61	41.54
YSURA include extension	13.04	19.43	20.39	19.29	17.33	17.80	14.52	17.73	19.26	13.51	8.78	5.59	186.68
Total	17.29	24.96	26.67	25.38	23.41	23.40	18.87	23.37	26.92	19.17	12.59	8.06	250.10
Barahona-Neiba Zone													
Area A1 (Azua Zone)	4.13	5.94	7.26	7.28	6.72	4.84	3.77	5.17	7.68	5.86	3.92	2.46	65.02
Area B1	5.61	6.18	7.03	7.02	8.45	7.90	6.55	7.11	9.72	7.80	6.31	5.28	84.96
Aguacatico	1.52	1.65	1.87	1.84	2.21	2.10	1.76	1.91	2.52	1.99	1.66	1.44	22.47
Area B2	23.10	26.74	28.62	22.33	20.17	20.06	20.67	25.53	35.88	31.51	29.74	21.97	306.93
Area B3	5.76	6.35	7.22	7.19	8.63	8.08	6.70	7.24	9.86	7.93	6.47	5.43	86.86
Area B4	0.74	0.82	0.93	0.93	1.12	1.04	0.87	0.94	1.29	1.03	0.84	0.71	11.26
Area B5	3.33	3.65	4.11	4.05	4.82	4.46	3.66	3.98	5.47	4.46	3.70	3.16	48.85
Area B6	5.80	6.28	6.98	6.83	8.15	7.56	6.20	6.78	9.36	7.71	6.49	5.58	83.74
Total	49.99	57.61	64.03	57.47	60.87	56.05	50.19	58.65	81.78	68.29	59.12	46.03	710.09
Total	79.11	115.59	146.22	113.67	93.56	87.72	94.18	129.59	153.88	125.21	96.85	69.59	1305.17

*: served by the San Juan river

Area from YSURA H.R : a group of small areas directly derived water from YSURA Head Race by private pipes.

Area A1 : irrigation area in the reaches from Villar Pando to Los Guiros up

Area B1 : irrigation area in the reaches from Los Guiros to Santana upstream

Area B2 : Santana irrigation area

Area B3 : irrigation area in the reaches from Santana downstream to Tomate-Mena upstream

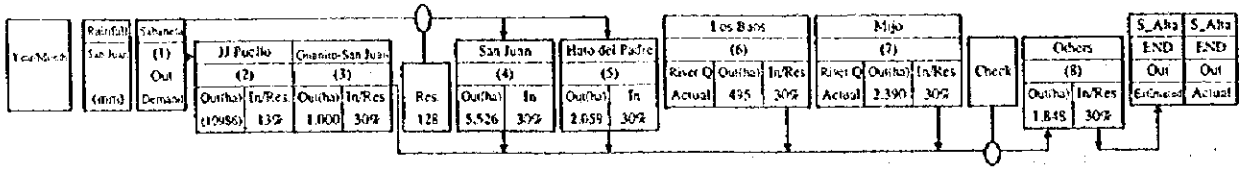
Area B4 : irrigation area in the Tomate-Mena system

Area B5 : irrigation area in the reaches from Tomate-Mena downstream to Palo Alto upstream

Area B6 : irrigation area in the reaches from Palo Alto

Table 16 Water Balance Simulation by Irrigation Block ··· San Juan Block

Proposed condition (with project)

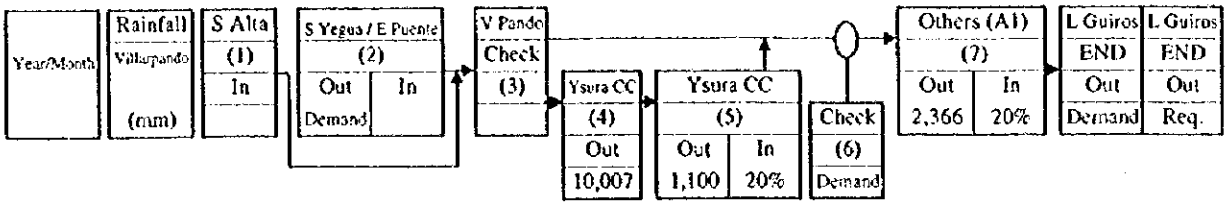


	(unit)	(mm)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)
1981		1269.8	187.7	103.7	74.0	25.4	56.2	62.9	104.2	31.3	29.3	8.8	28.1	4.5	25.0	214.7	45.8	182.7	529.3	35.2	504.6	504.6	758.8
1982		733.2	204.7	103.7	70.6	25.4	52.8	32.6	104.2	31.3	29.3	8.8	18.4	4.5	15.3	160.9	45.8	128.8	329.9	35.2	305.3	305.3	467.1
1983		1010.1	198.9	103.7	62.7	25.4	44.9	43.6	104.2	31.3	29.3	8.8	11.0	4.5	7.8	108.7	45.8	76.7	319.9	35.2	295.2	295.2	284.2
1984		903.8	196.0	103.7	67.8	25.4	50.0	42.6	104.2	31.3	29.3	8.8	14.3	4.4	11.2	118.3	45.6	86.4	328.3	35.2	303.6	303.6	-
1985		788.5	210.9	103.7	52.9	25.4	35.1	27.7	104.2	31.3	29.3	8.8	13.5	4.5	10.3	125.9	45.7	93.9	268.3	35.2	243.7	243.7	-
1986		883.9	202.5	103.7	59.0	25.4	41.2	40.4	104.2	31.3	29.3	8.8	17.3	4.5	14.1	112.7	45.8	80.6	315.7	35.2	291.1	291.1	385.9
1987		1123.7	184.0	103.7	82.8	25.4	65.0	56.9	104.2	31.3	29.3	8.8	11.7	4.5	8.6	138.8	44.9	107.3	410.7	35.2	386.0	386.0	384.6
1988		1015.9	193.8	103.7	72.5	25.4	54.8	45.4	104.2	31.3	29.3	8.8	14.6	4.5	11.5	133.3	45.8	101.3	356.2	35.2	331.6	331.6	497.4
1989		1030.2	190.7	103.7	75.5	25.4	57.7	49.6	104.2	31.3	29.3	8.8	17.1	4.5	13.9	159.9	45.8	127.8	404.0	35.2	379.3	379.3	463.2
1990		905.0	201.8	103.7	67.1	25.4	49.4	42.4	104.2	31.3	29.3	8.8	24.9	4.4	21.8	112.4	45.8	80.3	331.9	35.2	307.2	307.2	410.3
1991		512.3	219.1	103.7	49.8	25.4	32.0	18.1	104.2	31.3	29.3	8.8	10.0	4.1	7.1	128.0	45.8	95.9	224.1	35.2	199.5	199.5	280.2
1992		1267.9	191.1	103.7	72.3	25.4	54.5	59.8	104.2	31.3	29.3	8.8	5.0	2.3	3.4	133.4	44.2	102.5	413.5	35.2	388.9	388.9	625.3
1993		968.5	193.9	103.7	29.2	25.4	62.9	45.7	104.2	31.3	29.3	8.8	21.8	4.5	18.7	138.2	45.8	106.1	369.4	35.2	344.7	344.7	-
1994		664.6	211.5	103.7	51.4	25.4	33.6	25.8	104.2	31.3	29.3	8.8	28.6	4.5	25.4	118.1	45.8	86.1	266.9	35.2	242.3	242.3	-
Mean		934.1	199.0	103.7	67.0	25.4	49.2	42.4	104.2	31.3	29.3	8.8	16.9	4.3	13.9	135.9	45.6	104.0	347.7	35.2	323.1	323.1	-

Note: MCM; Million cubic meter
Out; Water extraction from the source (irrigation area in hectare in the above)
In; Return flow to the source (return flow rate in percent in the above)
In/Res.; Return flow, inflow from the residual catchment and the remaining flow to the downstream
Actual; Actual discharge in the records
Estimated; Estimated discharge by the simulation

Table 17 Water Balance Simulation by Irrigation Block ··· Azua Block

Proposed condition (with project)



	(uni	(mm)	(MCM)	(MCM	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM	(MCM)	(MCM)	(MCM)
1981		584.3	504.6	283.6		721.7	250.6	21.9	4.4	471.2	65.2	13.0	428.8	441.8
1982		415.2	305.3	506.5		807.7	250.6	21.9	4.4	557.1	65.2	13.0	514.1	527.1
1983		665.6	295.2	569.2		848.8	250.6	21.9	4.4	598.2	65.2	13.0	560.0	573.0
1984		409.1	303.6	552.3		853.7	250.6	21.9	4.4	603.2	65.2	13.0	563.7	576.7
1985		444.6	243.7	576.0		805.6	250.6	21.9	4.4	555.1	65.2	13.0	512.4	525.4
1986		475.2	291.1	448.4		722.6	250.6	21.9	4.4	472.0	65.2	13.0	430.1	443.1
1987		584.4	386.0	448.7		815.4	250.6	21.9	4.4	564.9	65.2	13.0	523.9	536.9
1988		551.2	331.6	479.5		793.8	250.6	21.9	4.4	543.3	65.2	13.0	504.1	517.1
1989		746.5	379.3	493.1		837.3	250.6	21.9	4.4	586.7	65.2	13.0	550.5	563.5
1990		514.9	307.2	549.0		821.1	250.6	21.9	4.4	570.6	65.2	13.0	535.0	548.0
1991		447.1	199.5	641.2		840.7	250.6	21.9	4.4	590.1	65.2	13.0	558.5	571.5
1992		313.1	388.9	480.1		835.8	250.6	21.9	4.4	585.2	65.2	13.0	548.2	561.3
1993		617.3	344.7	458.7		791.6	250.6	21.9	4.4	541.0	65.2	13.0	502.9	515.9
1994		670.6	242.3	540.3		778.0	250.6	21.9	4.4	527.5	65.2	13.0	491.1	504.1
Mean		531.4	323.1	501.9	-	805.3	250.6	21.9	4.4	554.7	65.2	13.0	515.9	529.0

Note: MCM; Million cubic meter

Out; Water extraction from the source (irrigation area in hectare in the above)

In; Return flow to the source (return flow rate in percent in the above)

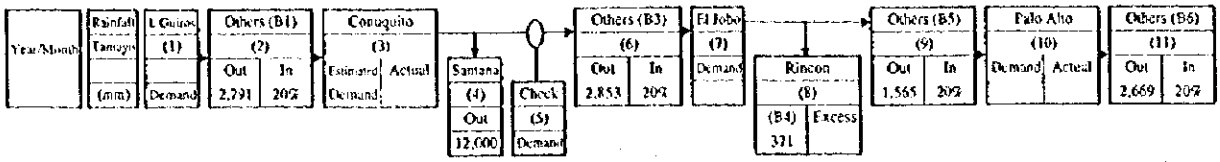
In/Res.; Return flow, inflow from the residual catchment and the remaining flow to the downstream

Actual; Actual discharge in the records

Estimated; Estimated discharge by the simulation

Table 18 Water Balance Simulation by Irrigation Block ··· Barahona Block

Proposed condition (with project)



	(uni	(mm)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)
1981		481.7	441.8	107.5	21.5	334.4	-	306.7	183.5	86.9	17.4	96.6	11.3	-	48.9	9.8	53.9	924.4	83.8	16.8
1982		271.5	527.1	107.5	21.5	419.7	-	306.7	193.6	86.9	17.4	106.7	11.3	-	48.9	9.8	64.0	381.8	83.8	16.8
1983		341.8	573.0	107.5	21.5	465.6	-	306.7	198.1	86.9	17.4	111.2	11.3	-	48.9	9.8	68.5	-	83.8	16.8
1984		248.7	576.7	107.5	21.5	469.2	543.6	306.7	199.1	86.9	17.4	112.2	11.3	-	48.9	9.8	69.4	181.7	83.8	16.8
1985		655.3	525.4	107.5	21.5	418.0	412.8	306.7	195.6	86.9	17.4	108.7	11.3	-	48.9	9.8	66.0	218.1	83.8	16.8
1986		348.8	443.1	107.5	21.5	335.7	-	306.7	189.5	86.9	17.4	102.6	11.3	-	48.9	9.8	59.8	422.0	83.8	16.8
1987		476.9	536.9	107.5	21.5	429.5	513.6	306.7	195.6	86.9	17.4	108.7	11.3	-	48.9	9.8	65.9	-	83.8	16.8
1988		254.4	517.1	107.5	21.5	409.7	867.4	306.7	194.5	86.9	17.4	107.6	11.3	-	48.9	9.8	64.8	-	83.8	16.8
1989		303.6	563.5	107.5	21.5	456.1	-	306.7	197.6	86.9	17.4	110.7	11.3	-	48.9	9.8	67.9	-	83.8	16.8
1990		354.1	548.0	107.5	21.5	440.6	-	306.7	196.6	86.9	17.4	109.7	11.3	-	48.9	9.8	66.9	-	83.8	16.8
1991		157.8	571.5	107.5	21.5	464.1	666.9	306.7	199.1	86.9	17.4	112.2	11.3	-	48.9	9.8	69.4	-	83.8	16.8
1992		497.2	561.3	107.5	21.5	453.8	-	306.7	197.1	86.9	17.4	110.2	11.3	-	48.9	9.8	67.5	-	83.8	16.8
1993		449.6	515.9	107.5	21.5	408.5	-	306.7	194.3	86.9	17.4	107.5	11.3	-	48.9	9.8	64.7	-	83.8	16.8
1994		557.4	504.1	107.5	21.5	396.7	-	306.7	193.8	86.9	17.4	106.9	11.3	-	48.9	9.8	64.2	-	83.8	16.8
Mean		385.6	529.0	107.5	21.5	421.5	-	306.7	194.8	86.9	17.4	108.0	11.3	-	48.9	9.8	65.2	-	83.8	16.8

Note: MCM; Million cubic meter
Out; Water extraction from the source (irrigation area in hectare in the above)
In; Return flow to the source (return flow rate in percent in the above)
In/Res.; Return flow, inflow from the residual catchment and the remaining flow to the downstream
Actual; Actual discharge in the records
Estimated; Estimated discharge by the simulation

Table 19 Salient Features of the Proposed Projects in the Yaque del Sur River Basin (1/5)

Sector	Agricultural development			Agricultural Support Services		
Name of Project	Landuse Plan	Crop Production Plan	Coffee Production Improvement Project	Rural Development Fund and Fund for the Rural Poor	Plan for Strengthening CIAZA Research Center	Plan for Seed Multiplication
Basic Concept of the Plan	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 problem of soil erosion due to the inadequate land use management. In order to expedite to spread reforestation and adequate landuse, fixed cultivation should be introduced in the place of shifting cultivation. In the irrigated area, the basic development concept is set up with the improvement of the crop intensity through the rehabilitation of the existing irrigation system instead of new land development except 6,540 ha in total composing of the Galvan groundwater development project (540 ha) and the on-going INDRHI project (5,950 ha).	The irrigation is essential for the crop production in the study area because of scarcity of rainfall. The improvement of irrigation efficiency as a result of implementation of the proposed irrigation and drainage projects and Yaque der 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.	There are about 12,000ha of land in the mountainous areas of Bahoruco and Azua provinces where small holders having about 2 ha each have plant coffee. About 60 % of the coffee areas are deteriorated. An economical durability of coffee trees are over and unit yield of coffee is low. Also quality of coffee products are low due to deterioration of harvesting and processing facilities. The smallholders in this area is low in their living standard. Rural roads for the transportation of products are deteriorated. It is planned in order to increase farm income that increasing unit yield of coffee and quality should be performed by introducing improved farming, replanting of the old coffee trees and improvement of processing facilities. The target of the project is about 7,200ha of deteriorated coffee areas and 3,500 smallholders. For expansion of improved farming to small holders, education and training should be carried out for the relevant people. Pilot scheme will be done for providing basic data for successful and smooth operation of the project.	The poor access to the credit is one of the main constraints to hinder the agricultural production. In the study area, the settlement farmers have received credit from agricultural bank through the program prepared by the Ministry of Land Reform. Most farmers do not use the credits. The interest of the credit is 18 % per year. Credit service is provided with individuals not groups. The basic concept of credit plan is to apply 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 institute within the Special Fund for Agricultural Development (FEDA) that has carried out through trust fund on a small scale. This fund is invested to the poorest in the study area through the local financial institutions such as women's associations, youth associations, NGOs and cooperatives.	There are two Agricultural Research Centers (CIAZA in Azua and CIAS in San Juan) in the study area that are under Vice Ministry of Agricultural Research and Extension, SEA. Over 90 % of the budgets of the Centers are allocated personnel cost and it appears that function on research is not performed actually. Further, the number of trained staff and equipment/facilities for research work are in shortage. The basic concept of the plan is to strengthen research function of CIAZA which will provide basic technology necessary for the successful implementation of the proposed agriculture, and irrigation and drainage projects. For this purpose, CIAZA integrates all stockholders in the generation and deliver of technology. Also reinforcement of institutional capacity as well as equipment/facilities will be undertaken.	Most of the farmers in the study area use seeds from the last harvest. The most seeds used are old and deteriorated that is one of the constrains to force unit yield of crops to be low. Through the Government has promoted increasing improved varieties, quantity of such seeds are small and insufficient. An increase of production of improved variety is essential for successful performance of the proposed irrigation and drainage development projects. Seed multiplication work is now undertaken by CIAZA and APASJM (association of farmers of San Juan de la Maguana). The basic concept of the project is to carry out seed multiplication by strengthening productive function of the existing these two organizations. The objective seeds are paddy, bean, pigeon pea, maize, sorghum, plantain and banana.
Content of the Plan	In order to promote the reforestation and adequate use of steep lands, the present 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 hereinafter. The rural peoples are expected through these projects to get basic technology and information for fixed cultivation instead of the present shifting cultivation. With rehabilitation and improvement project for irrigation system, the crop intensity would be enhanced upto 125 %.	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. Considering the farmers' intention, however, the followings should be carried out. (1) Considering the farmers' intention, annual cropping intensity should be decided based on the distribution program to each irrigation system. (2) Following the Government policy, the cropping area of the paddy which needs high water requirement remains unchanged. (3) For the sugarcane area in the Barahona and Enriquillo irrigation district, sugarcane production is controlled applying the improved farming practices based on the capacity of the existing sugar factory. (4) Planting area of the banana remains unchanged according to the market forecast by the Ministry of Agriculture. 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.	(1) formulation of detailed plan on the coffee production improvement, (2) formation and strengthening of 180 farmer's associations, (3) education and training for 4-coffee specialist, 15-extension workers and 180- nucleus farmers, (4) establishment of 2 pilot schemes (80 ha in total), (5) production : construction of nurseries (14.4 ha), replanting 1.2 million trees by new trees, introduction of improved farming, improvement and provision of harvesting and processing facilities, construction of 18 km access road and improvement of 66 km rural roads.	(1) The Yaque del Sur Rural Development Fund will be instituted in the Agricultural Bank. (2) The member of the Fund consists of 1-manager, 1-secretary, 6-cretit / accounting staff, 3-credit officer, 1-lawyer and 1-accountant, (3) The Fund will provide group loans with organizations such as water user's organizations (irrigation nucleus), agricultural cooperatives, NGOs, etc. (4) procurement of necessary office equipment, (5) training for the staff, and (6) Capital of the Fund : 5 million US$. With respect to the 'Fund for the Rural Poor', (1) The Fund will be established within FEDA for the Poor through the local financial institution, (2) The Fund consists of 1-manager, 1-secretary and 3-credit officer, (3) procurement of necessary office equipment, (4) training for the staff,	(1) The 'Research Trust Fund' will be established to obtain research funds and efficient development of applied technology. The member of the Fund is composed of governmental agencies, private sector (agro-processing companies, etc.), academic research sector (ISA, USAID, etc.), water user's organization, NGOs, etc.. CIAZA will employ additional 5 staff. (2) The capability of the present staff will be improved by training of 'Master Degree Program' that is now performed by the Government, ISA and FDA, and various training/seminar programs. (3) procurement of necessary equipment and facilities for laboratory, and (4) expansion of the experimental farms in Barahona (from 12.5 ha at present to 200 ha) and procurement of agricultural machinery	(1) the target of production for improved seeds (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), (2) CIAZA covering with seed and seedling requirement in Azua, Yaque del Sur and Lago Enriquillo irrigation districts and APASIM in charge of seed requirement in Sa Juan irrigation district, (3) construction of cold storage (CIAZA : 260 m2, APASIM : 2,900 m2) and (4) procurement of tractors and related attachments
Total Project Cost			249.8 million pesos (formation of association : 11.4 million pesos, education and training: 20 million pesos, vehicle procurement : 0.7 million, pilot scheme : 3.9 million pesos, road improvement:15.5 million pesos)	The Rural Development Fund: 16.9 million pesos (procurement cost of office equipment and vehicle, education and training cost, staff salaries, operation cost), The Fund or the Rural Poor:10.5 million pesos.	24 million pesos (procurement of laboratory equipment/facility and agricultural machinery : 4.1 million pesos, education and training cost : 3.2 million pesos, operation cost : 2.7 million pesos)	5.4 million pesos (procurement of agricultural machinery : 1.6 million pesos, procurement of equipment for lab : 0.7 million pesos, storage and other building construction : 3.1 million pesos)
Total Benefit			77.1 million pesos			
Internal Rate of Return			13%			
Implementation Years			11 years	6 years	6 years	3 years
Number of Bneficiaries			3,500 farm households			
Implementation Agency			Ministry of Agriculture	Agricultural bank for the rural development fund and FEDA for the fund to the rural poor	Ministry of Agriculture	Ministry of Agriculture

Table 19 Salient Features of the Proposed Projects in the Yaque del Sur River Basin (2/5)

Sector	Agricultural Support Services			Irrigation and Drainage		
Name of Project	Plan for Strengthening Extension Services	Plan for Market Information Systems	Plan for Agricultural Cooperatives	Night Storage Pond Project	Guanito San Juan Irrigation System Improvement Project	YSURA Area Irrigation Improvement Project
Basic Concept of the Plan	The present extension work is carried out through the channel from Vice-minister of research and extension of central SEA, region, province to sub-zone. There are 178 of extension workers in the study area. The activities of extension work is limited due to (1) insufficient number of trained extension workers, (2) lack of transport facilities for extension workers and (3) lack of modern extension aids for technical transfer. The basic concept of the project is paid on special emphasis on 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.	There are no organizations that systematically provide data and information about prices of farm input and outputs, location of sale and market, market requirement classified by grade, list and activities of dealers on agro-processing and machinery. SEA provides irregular services of market information with farmers. 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, etc,. Under JAD in Santo Domingo there are several branches in which provincial agricultural cooperatives take part. Market information are exchanged between JID headquarters and the branches. It is necessary to strengthen these market information system through reinforcement of communication equipment and staffing. The present member of the branches consists of only farmer's cooperatives. Participation of water user's organization, relevant agro-processing companies, etc,. will be expected.	There are about 300 agricultural cooperatives at village level and 2 provincial associations of the agricultural cooperatives at San Juan and Azua provinces. These cooperative and associations are weak institutionally and provide poor services on market. The basic concept of the project is to strengthen institutional capacity of cooperatives by setting up new 2 provincial associations at Barahona and Bahoruco provinces. Also Affiliation of the associations will be created at the basin level. Reinforcement of activities of the cooperatives should be carried out being paid with an emphasis on cooperative purchase and processing and marketing business.	The San Juan irrigation area suffers from the shortage of water resources. It is, however, difficult to develop new water source from the economic view point. At present the Government is aiming at the enhancement of irrigation conveyance efficiency by the improvement of irrigation canals with the provision of lining from the main canal to the tertiary canals and the related structures under PRODAS and PROMASIR. This project aims at the increase of crop production and then of farmers' income by establishing the foundation, in which an improved farming technology can be introduced and improving the irrigation efficiency by changing irrigation water supply from present 24 hour supply to daytime supply by the provision of night storage ponds in the existing major systems ,of which total irrigation area is 20,958 ha, such as (1) the Jose Joaquin Puello, (2) the Hato del Padre, (3) the San Juan, which are served by Sabaneta Dam, and (4) the Mijo irrigation system, which is served by the Mijo river.	This project is the improvement of the existing Guanito San Juan irrigation system serving the irrigation area of 1,000 ha located in the south of the San Juan irrigation system area. The water resources are the river water of the San Juan river mainly composed of return flow from J.J. Puello and San Juan irrigation areas. This project is the plan to efficiently utilize limited water resources as same as the San Juan Irrigation District Night Storage Pond Project. This project aims at the increase of crop yield and production and then increase of farmers' income by establishing the foundation, in which an improved farming technology can be introduced improving the irrigation efficiency by the provision of night storage ponds in the area and the provision of lining of the main canal in the earthen canal reaches.	YSURA area is irrigated with water of the Yaque del Sur river diverted at Villarpando and flowing through the YSURA Headrace, which is a transbasin canal to the Tabara river and then diverted by Tabara headworks. Drainage Improvement program (PROMATRES) financed by World Bank is scheduled to be implemented. This proposed YSURA Area Improvement Project is the project to efficiently use limited water resources, mainly of the Sabana Yegua dam. This project aims at the increase of crop yield and production and then increase of farmers' income by establishing the foundation, in which an improved farming technology can be introduced and improvement of the irrigation efficiency. The project mainly consists of (1) improvement of field irrigation efficiency by changing the irrigation water supply from the current 24 hour supply to daytime supply by providing night storage ponds in the existing system and (2) improvement of canal conveyance efficiency by the improvement of main and lateral canals and the intake of Tabara headworks.
Content of the Plan	(1) All extension workers will be trained on four aspects: technical issues, methodological aspects, managerial aspects and organization aspects, (2) professional staff of SEA and universities will be assigned as trainees, (3) training programs consists of short course program, workshop, seminars, conference, field trips, etc., (4) procurement of necessary equipment and facilities for two training centers	(1) In addition to the present branches of San Juan and Azua provinces, new branches at Barahona and Bahoruco provinces will be established, (2) The Barahona branch will be set up in the present Coffee Producer's Association and the Bahoruco branch is instituted in Agricultural cooperatives that will became member of this system, (3) procurement of communication and office equipment necessary for making market information system among JAD headquarters and four branches, (4) education and training for system operators	(1) setting up of the Yaque del Sur farmer's Market Board, (2) establishment of 2 provincial farmers associations in Barahona and Bahoruco provinces, (3) technical guidance and training for the members of the Market Board and provincial associations and (4) procurement of necessary equipment and materials.	(1) Jose Joaquin Puello : construction of night storage pond at 15 sites, total storage capacity of 523,000 m3, earthwork volume of 550,000 m3 (2) Hato de Padre : construction of night storage pond at 3 sites, total storage capacity of 98,000 m3, earthwork volume of 120,000 m3 (3) San Juan : construction of night storage pond at 8 sites, total storage capacity of 263,000 m3, earthwork volume of 300,000 m3 (4) Mijo irrigation system : construction of night storage pond at 5 sites, total storage capacity of 114,000 m3, earthwork volume of 170,000 m3 (5) Improvement of canals and related structures.	(1) Construction of night storage pond at 2 sites, total storage capacity of 48000, total earthwork volume of 70,000 m3, (2) Concrete lining of 8 km (3) Improvement of canals and the related structures.	(1) Rehabilitation and improvement of offtakes and the canal related structures, 180 numbers in total, (2) Rehabilitation of canal lining damaged, (3) Repair or replacement of existing gates of Tabara headworks, (4) Bank protection works at Tabara headworks, (5) Construction of night storage ponds at 14 sites (361,000 m3 in total).
Total Project Cost	30 million pesos (procurement cost of equipment and facilities : 2.1 million pesos, training cost : 7.5 million pesos, vehicles : 1.1 million pesos, operation cost:10.6 million pesos, other cost: 1.5 million pesos)	7.5 million pesos (procurement cost : 0.7 million pesos, vehicle procurement : 0.6 million pesos, staff salaries : 3.1 million pesos, operation cost : 3.1 million pesos)	19.7 million pesos (procurement of equipment : 0.3 million pesos, guidance cost : 5.3 million pesos, education and training cost : 4.2 million pesos, staff salaries : 7.8 million pesos, operation cost :2.1 million pesos)	841.6 million pesos (of them, construction cost for night storage ponds is 419.8 million pesos)	75 million pesos	459 million pesos
Total Benefit				318.7 million pesos	16.3 million pesos	159.2 million pesos
Internal Rate of Return				20%	14%	21%
Implementation Years	6 years	6 years	5 years	6 years	2 years	3 years
Number of Beneficiaries				5,800 farm households	288 farm households	4,500 farm households
Implementation Agency	Ministry of Agriculture	JAD under supervision of the Ministry of Agriculture	Ministry of Agriculture	INDRHI	INDRHI	INDRHI

Table 19 Salient Features of the Proposed Projects in the Yaque del Sur River Basin (3/5)

Sector	Irrigation and Drainage					
Name of Project	YSURA Extension Area Development Project	YSURA Headrace Small Irrigation System Improvement Project	Yaque de Sur Lower Reaches Irrigation and Drainage Project	Galvan Groundwater Irrigation Project	Yaque del Sur Small Gravity Irrigation System Improvement Project	Operation and Maintenance Plan
Basic Concept of the Plan	YSURA extension area, 2,275 ha is located in the downstream of the YSURA irrigation area. The YSURA main canal is of earthen canal type in the extension area. The irrigation canals and the related structures are incomplete. Groundwater resources are expected especially in the lower part of the extension area. This project aims at the increase of crop yield and production and then increase of farmers' income by establishing the foundation, in which an improved farming technology can be introduced and improvement of the irrigation efficiency by the improvement of canal and related structures including canal lining and construction of night storage ponds and tubewells expecting the utilization of the groundwater resources as well as the surface water delivered from the YSURA canal.	The project area of 1,100 ha in total is distributed discontinuously along the south side of the YSURA headrace. Farmers divert water from the YSURA headrace through plastic pipes installed by themselves. The total amount of diverted water is assumed to be extremely more than the irrigation water demands. This project aims at the increase of crop yield and production and increase of farmers' income by establishing the foundation, in which an improved farming technology can be introduced and improvement of the irrigation efficiency by the improvement of the irrigation water management and the operation and conveyance efficiency. For this purpose, permanent intakes will be placed unifying the existing ones as much as possible and canals and related structures are improved.	The project area is 19,500 ha extending astride the Yaque del Sur river in the downstream of the Santana headworks. Of the project area, 13,800 ha is served by gravity irrigation systems such as the Santana canal system in the right bank and the Vicente Nobre canal system in the left side. The remaining areas are irrigated by pumps. The project area has disadvantage in the water availability especially in the dry season caused by the defective structures of the Villarpando headworks. Canals and the related structures have been deteriorated and the most of the canals are of earthen type especially in the Santana sugarcane area of 12,000 ha. The present irrigation efficiency seems to be lower than the other areas. The area of 5,600 ha currently served by pumps suffers from the unstable water availability caused by erratic electric supply. It has brought a decline in crop production. The project aims at the increase of crop yield and production and increase of farmers' income by establishing the foundation, in which an improved farming technology can be introduced by the improvement of the irrigation water management. For this purpose, (1) irrigation water supply is shifted from 24 hour supply to the daytime supply by provision of night storage ponds, (2) Santana headworks and the Santana and Vicente Nobre canal systems are improved, and (3) an irrigation canal is newly constructed along the left bank of the Yaque del Sur river so as to connect to existing pump irrigation systems as much as possible.	An alluvial fan develops along Neyba - Galvan road in the extent of about 15 km in the east-west direction and 3 km in the north-south direction in the foot of the Neyba mountains. According to insufficient data, it is expected that a tubewell produces 20 to 30 litre/sec and an area of 540 ha in total can be irrigated.	The project objective areas are 7,500 ha in total consisting of (1) irrigation areas, 2,790 ha in total located along both banks of the Yaque del Sur river in the reaches from Los Guiros to the Santana weir, (2) irrigation areas, 2,370 ha in total located along both banks of the Yaque del Sur river in the reaches from Villarpando to Los Guiros, (3) Vallejuelo irrigation areas, 495 ha in total located along the Los Baos river in San Juan Irrigation District, and (4) the other small-scale irrigation area of 1,850 ha. Small irrigation systems mostly divert water through free intakes without permanent structures or simple intakes. In the irrigation areas located along the Yaque del Sur river, irrigation systems especially intakes are sometimes damaged by flood. Most of the irrigation systems are composed of earthen canals and fragile. The project aims at the increase of crop yield and production and increase of farmers' income by establishing the foundation, in which an improved farming technology can be introduced by the improvement of the irrigation water management. For this purpose, The project includes (1) construction of an intake structure equipped with a steel gate and improvement of a main canal and an access road for the areas of the above (1) and (2), and improvement of irrigation canals and the related structures in the other areas.	O&M of present irrigation and drainage systems are carried out by INDRHI in the area where no water user organization (WUO) exists. Even in the area WUO exists, INDRHI is substantially involved in O&M works. This O&M plan proposes that WUO carries out O&M works for irrigation and drainage facilities under his responsibility. After WUO functions, the Irrigation District office will function as a superintendent and a technical assistant, and prepare overall water distribution program in his jurisdiction. Small distribution canals and field canals will be maintained by farmers' themselves of every Nucleuses as a communal work. Major 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 on WUO's responsibility. In case of the emergency repairing or a large-scale maintenance, the Irrigation District Office will assist WUO to repair the damaged portion or to carry out the large-scale maintenance works mobilizing construction equipment owned by the Irrigation District office.
Content of the Plan	(1) Concrete lining about 20 km in main and lateral canals, (2) Construction of distribution and field canals, (3) Construction of two night storage ponds (total storage capacity of 55,000 m3) (4) construction of tubewells about 60 numbers and small-scale sprinkler irrigation systems.	(1) Construction of steel pipe intakes equipped with valves at about 75 sites along the YSURA head race, (2) Improvement of canals and the related structures.	(1) Improvement of Santana Headworks (Replacement of sand flushing sluices: steel roller gates 2 sets, 3 m x 3 m, and intake structures with steel slide gates 1.5 m x 1.5 m, rehabilitation of the overflow-type weir and banks), (2) Improvement and construction of canals of about 900 km in total and the related structures serving 20,000 ha, (3) Construction of a siphon, about 150 m in length from the Santana intake across the Yaque del Sur river, (4) Construction of night storage ponds at 10 sites for the left bank area (total storage capacity of 540,000 m3), (5) Construction of night storage ponds at 17 sites for the Santana and right bank area(total storage capacity of 580,000 m3), (6) Drainage canal system improvement, and (7) Construction of night storage ponds at 4 sites for the other areas (total storage capacity of 110,000 m3)	(1) Construction of tubewells at 18 to 20 points, (2) Construction of irrigation systems.	(1)Construction of intake structures equipped with a steel slide gate, about 40 sites, (2) Canal lining of 1 km in each irrigation system and protection measures against flood, (3) Construction of an access road, and (4) Improvement and construction of canals and the related structures,	A cropping program and an irrigation schedule are essential for proper water management. They will be prepared before the planting season. Then, based on the schedule, water is released from the dams and diverted at the intake of each of irrigation systems. For these system operation as well as maintenance works, WUO will be set up as stated in plan for strengthening WUOs.
Total Project Cost	353.7 million pesos	51 million pesos	2,424 million pesos	65.5 million pesos	382.1 million pesos	
Total Benefit	24. 8 million pesos	22.4 million pesos	688.7 million pesos	25.8 million pesos	130.6 million pesos	
Internal Rate of Return	5%	24%	16%	24%	22%	
Implementation Years	3 years	3 years	7 years	3 years	3 years	
Number of Beneficiaries	1,300 farm households	740 farm households	4,400 farm households	?	3,650 farm households	20,700 farm households
Implementation Agency	INDRHI	INDRHI	INDRHI	INDRHI	INDRHI	INDRHI

Table 19 Salient Features of the Proposed Projects in the Yaque del Sur River Basin (4/5)

Sector	Irrigation and Drainage	Rural Infrastructure development			Rural Road Improvement Plan
Name of Project	Plan for Strengthening WUOs	Magueyal Mini-hydro development Project	Rural Water Supply Plan	Rural Road Improvement Plan	Other Social Infrastructure development Plan
Basic Concept of the Plan	Water users will set up WUO in every irrigation systems one by one getting full assistance from INDRHI and then the Irrigation District and Zone offices will transfer O&M works to WUOs. For this purpose, WUOs will be reinforced. The organization is similar to the Sabaneta Dam Irrigation Committee (SIC) or the YSURA Canal Irrigation Committee (YIC) in principle. The organization is constituted by three or four hierarchy such as (1) nucleus (20 to 60 ha), (2) sub-committee (100 - 1,000 ha), (3) association (1,000 - 10,000 ha), and (4) irrigation committee (one organization in one river).	Generation of the electricity in the Study area is absolutely short, in which deficit would be covered by the development of new power stations. To cope with the rural electrification, INDRHI has a strong intention to develop some hydropower stations, both dam projects and mini-hydropower stations in the Yaque del Sur river basin. The potential projects have been identified since early 1970's, and the INDRHI made various studies and designs, most of which however have not been realized so far, due mainly to the lack of budgetary arrangement and the relevant data and information have been mostly lost. Since promising dam project has 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. For the Magueyal project, a mini-hydropower station is planned to be constructed on the existing YSURA headrace utilizing maximum the canal water (25 m3/sec) taken at Villarpando Intake for power generation after discharging water downstream for the YSURA irrigation area. 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. This scheme needs also more detailed investigation including topographic survey and geological study.	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 provinces 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. 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. These rural water supply schemes depend their water sources on groundwater where it is expected and surface water in the hilly area.	Most of the rural roads are not sufficiently maintained in the study area due to the lack of financial resources, badly affecting the transportation of the farm input and 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 rural roads. In addition, supply of maintenance equipment are included for the project in order to enable the local government to continuously maintain the farm road network. The responsible organization is assumed to be the public works section of the provincial office.	In the Study area, there exist a number of community halls, most of which are located in only center of some municipalities, while community halls are not found in the rural area and some other place are utilized for this purpose, for example schools, churches, villagers' residences. Community hall is therefore proposed to be constructed for not only villagers' meeting but also some training/education programs in the rural area. Meanwhile, establishment of water users' organization require their offices including space for their meeting. In the present study, construction of community halls and water user's office are proposed in the rural area.
Content of the Plan	Future jurisdiction of WUO is as follows : (1) In San Juan Irrigation zone, the existing SIC will extend the management to the San Juan and Guanito San Juan Irrigation systems through the establishment of WUO in addition to the J. J. Puello and Hato del Padre irrigation systems. (2) As for Mijo system, an irrigation committee will be established under the assistance of PROMASIR. (3) YSURA area is managed by present YIC. (4) YSURA extension area is managed by a new WUO under YIC. (5) In the YSURA headrace area, nucleuses, sub-committees and then an association will be set up and then enters into YIC. (6) As for the area served by small gravity irrigation systems along the Yaque del Sur river, sub-committees and an association will be set up and enter into the proposed Irrigation Committee of the Yaque del Sur river (ICYDSR). (7) As for the lower reaches, sub-committees and an association will be set up and enter into ICYDSR. Setting-up of WUO will be implemented by the folowing procedure: - Identification of resources - farmers and leaders' capability, education level, will, organizer's ability, physical conditions, water availability, condition of irrigation and drainage facilities, etc. - Setting-up of an executing team and preliminary orientation to farmers' leader and groups - Selection of pilot project areas and orientation to farmers' leaders and farmers belonging to the selected areas - Formation of nucleuses and training about O&M of facilities and administration management - Formation of sub irrigation committees in a lateral level or a pump station level and support of them - Transference of Irrigation water management in their irrigation systems. - Formation of the irrigation association and then irrigation committee.	1) Construction of the Magueyal mini-hydro power station - Intake structure at YSURA headrace and settling basin - Pen stock 120 m and spillway channel 120 m - Tailrace canal 1,600 m and culvert on the national road - Power plant 2,600 kW - Transformer plant and transmission line 2) Improvement of Villarpando intake structure and YSURA headrace - Additional installation of intake gates (1.9 m x 2.5 m x 3 nos.) - Improvement of culvert	Rural water supply project by the surface water 1) 4 nos. in Azua province 2) 2 nos. in San Juan province 3) 1 nos. in Bahoruco province Rural water supply project by the surface water 1) 2 nos. in Bahoruco province 2) 1 nos. in Barahona province The design capacity is estimated with the unit requirement of 150 lit/day/person and according to the population projection in 2010. Construction work includes 1) tube well, 100 m and pumps, 0.5m3/min. or intake facilities and settling basin, 2) supply pipe, 3) reservoir, 4) booster pump, 5) distribution pipe and 6) elevated tank.	Total length of the 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 where required, shaping of unpaved road and repair / installation of road related structures. Road maintenance equipment to be supplied are bulldozers, back hoes, motor graders, water tanker, dump trucks, macadam rollers and their garages	1) Water user's office - Azua area 4 nos. - Bahoruco area 2 nos. - Barahona area 1 nos. 2) Community hall - Azua area 9 nos. - San Juan area 3 nos. - Bahoruco area 3 nos. - Barahona area 4 nos.
Total Project Cost		250 million pesos	115 million pesos	357 million pesos	198 million pesos
Total Benefit					
Internal Rate of Return					10 years
Implementation Years		6 years	10 years	10 years	10 years
Number of Beneficiaries	20,700 farm households				
Implementation Agency	INDRHI				INDRHI

Table 19 Salient Features of the Proposed Projects in the Yaque del Sur River Basin (5/5)

Sector	Environmental Conservation		Water Resources Development		Overall Water Management in Yaque del Sur River Basin
Name of Project	Reforestation Plan in the Upper watershed Area of Grande River	Wildlife Conservation Plan in Rincon Lagoon	J.J. Puello Dam Development Project	Sabana Yegua Dam Rehabilitation Project	Yaque del Sur Water Management Center
Basic Concept of the Plan	Most of the upperbasin of the Yaque del Sur river is steep. The squatters in the basin have performed shifting culture, which seriously affected vegetation in the basin. As a result, an annual transported sand sediment becomes 2.5 mm, which has seriously affected sedimentation of Sabaneta and Sabana Yegua dams. At present, PRODAS carried out soil conservation program in the upperbasin of San Juan. SEA performed soil conservation program in the Las Cuevas river basin in the Azua province. The concept of the project is that pilot reforestation scheme will be performed for the soil conservation. The location of the scheme will be the area along the Arroyo Limon river, a tributary of the Grande river, a tributary of the Yaque del Sur river. Along with the reforestation, the squatters should carry out an appropriate land use instead of shifting culture. For this purpose, introduction of the sedentary agriculture will be promoted for increasing farmer's income. Implementation of the project will be carried out by p	There are variable wildlife in and around the Rincon Lagoon. After the completion of Sabaneta and Sabana Yegua dams, river discharge at Palo Alto decreases 1/2 to 1/3 of previous one during the rainy season from August to December and the level of the Rincon seems to decrease. It is said that such situation gives the environmental change for the wildlife. It is necessary to conserve such variable fauna and flora. At present, there are few information of wildlife and environmental conditions around them. The basic concept of the project is to collect and monitor information of wildlife and environmental conditions around them for long time.	According to a water balance simulation under the proposed conditions, the total irrigation demand for the irrigation area of Sabaneta dam is 200 MCM out of 270 MCM inflow into the reservoir. A dam reservoir is proposed along the José Joaquin Puello Canal in order to increase local agricultural income. The design capacity of the headrace canal is 8 m3/sec, and any remaining capacity over and above the irrigation demand will be utilized to feed the reservoir. The reservoir will also perform the functions of regulating reservoir levels to decrease operational losses caused by 24-hour water supply.	Since the peak flood inflow in the completion year of the Sabana Yegua dam exceeded the designed value, the maximum flood recharge rate had to be re-estimated. With the new result that the existing spillways cannot accommodate the re-estimated flooding, the maximum operation level (MOL) of the reservoir is currently maintained at 10 m lower that the designed MOL of 396 m. This 10 m difference in water levels is equivalent to a storage loss of 100 MCM. The aim of this project is to improve the emergency spillway and raise the maximum operation level in order to achieve the designed volume of water to be held by the reservoir. After completion of the rehabilitation works, a flood warning system will be put in place taking into account the proposed flood release through the improved spillway. The dam will be operated under an overall water management plan.	Optimization of very limited water resources in the Yaque del Sur River basin is a key issue in the basin development. It is necessary to distribute water under an efficient management plan covering the entire basin including the Sabaneta and Sabana Yegua dams. The Villarpando headworks, which divert water to the Azua irrigation area and to the Yaque del Sur and Lago Enriquillo irrigation areas, do not distribute water properly especially during dry periods owing to structural deterioration of the facilities. Further, the headworks are solely operated by the Azua Irrigation District Office despite the headworks irrigating three Irrigation Districts. In terms of overall water management, real time and accurate water management are not being achieved due to the absence of an adequate telecommunications system. This project aims at optimal basin water management consisting of: (i) the improvement of structural deterioration of the Villarpando headworks, (ii) the establishment of a Yaque del Sur Water Management Center to conduct overall water management in the basin as an organization independent of the Irrigation District Offices, (iii) the setting up of a telemetering system, a flood warning system, a real time and adequate water distribution system, and a data control system (data transmission, monitoring and operation management, data processing), and (iv) training of staff working in water management.
Content of the Plan	(1) objective village and participatory farmers (La Majaguit, Gajo de Monte, Mata de Café and Vallecito, 720-farmer), (2) reforestation area: 720 ha, (3) detailed plan of the project, (4) legal action for the squatters, (5) formation of farmers and education and training, (6) construction of 3-nursery with 1,500m2 each, (7) reforestation, (8) construction of 27 km- rural roads and (9) monitoring for condition of reforestation, fire-control, etc.	(1) bench mark survey for variable flora and fauna in and around the Rincon Lagoon, (2) monitoring survey, (3) provision of equipment and facilities necessary for monitoring	The detailed design and construction of a rock-fill type dam of 9.5 MCM total capacity, 670, 000 m3 dam embankment volume, and a 425 m crest length. The catchment area of the dam is 9 km2 and the designed flooding rate is estimated at 200 m3/sec. Due to its small catchment, sedimentation volume is also estimated to be comparatively small at 10 % of the total reservoir capacity over 50 years. It is necessary to optimize the dam size on the basis of water balance simulation results.	(1) rehabilitation of the emergency spillway, (2) installation of a flood warning system as a part of the telemetering network system, (3) dam operation during dry periods using a standard drought storage curve.	(1) construction of the Yaque del Sur Water Management Center, (2) installation of the telemetering system, (3) rehabilitation of the Villarpando headworks, replacement of gates and lifting devices, slide gates (1.9 m x 2.5 m, three gates), and a sand flushing gate (a four-meter-wide radial gate), (4) provision of a gated discharge sluice (5) implementation of staff training programs for the water management.
Total Project Cost	15million pesos	4.6 million pesos	136.6 million pesos	371 million pesos for Improvement of spillway	86.2 million pesos (rehabilitation of Villarpando headwork:35.2 million pesos, telemetering systems and training: 51 million pesos)
Total Benefit					
Internal Rate of Return	5 years	10 years	5 years	3 years	6 years
Implementation Years	5 years	10 years	5 years	3 years	6 years
Number of Beneficiaries	720 farm households				20,700 farm households
Implementation Agency	INDRHI	The Ministry of Natural Resources	INDRHI	INDRHI	INDRHI