IRRIGATION DEVELOPMENT PLAN

Irrigation System and Irrigation Area

167. It is proposed to provide a new main canal from the existing Santana weir so as to supply water to the existing irrigation systems in Tamayo, Vicente Noble and the left side of the Yaque del Sur River. As for the right side bank, however, the downstream 11 pump irrigation areas of about 1,280 ha in total have difficulty being economically and topographically covered by gravity irrigation system. They are, therefore, improved as pump irrigation areas as they are. In both the proposed main canal system and the existing pump systems to be remained, night storage ponds are proposed to be provided along the main canal or near the pump stations in order to enhance the efficient use of water. The proposed irrigation areas are estimated at 5,885 ha.

Irrigation Water Requirement and Water Balance

168. The irrigation water requirements with Project condition was estimated in accordance with the proposed cropping pattern on the assumption that the irrigation water efficiency is 0.47 for upland crops and 0.58 for paddy. Annual irrigation water demand in the Project area is estimated at 171 million m^3. The unit irrigation requirement is estimated at 1.24 liter/sec/ha at the head of the proposed main canal or 1.11 liter/sec/ha at the head of the laterals in peak irrigation season.

169. The water balance considered in the Master Plan is under an "ideal" condition with enhanced irrigation efficiencies for all the irrigation systems. However, it is necessary to consider conditions during the transition period from the without-project to the fully developed condition. The water balance under a condition with; i) improved water distribution at Villarpando, ii) enhanced irrigation efficiency at the Lower Yaque del Sur Irrigation Area, and iii) present irrigation efficiency (without project condition) for the other existing irrigation systems, is considered for determining the irrigable area and evaluating the project. The simulation results show that the available volume of the water for the Project area would decrease by eight (8) per cent. In other words, it can be said that eight per cent of the proposed Lower Yaque del Sur Irrigation Area (5,885 ha) might not be fully irrigated without the improvement for the other systems.

170. Major project facilities to be improved or constructed are summarized as follows.

Villarpando headworks	Replacement of the intake gates and the sand flush gate with electric and manual-driven gates and construction of gated sluice to supply water to Yaque del Sur downstream
Santana headworks	Reconstruction of intake and sand flushing sluice
Main canal	Construction of 21 km long
Night storage ponds	10 locations along the main canal and 11 locations, one pond for each of the existing pump stations
Lateral	45 km long
Inspection road	35 km

171. In order to precisely divert water between the Azua area and the Yaque del Sur- Lago Enriquillo area, it is proposed for Villarpando headworks to provide a gate structure to discharge water to the Yaque del Sur downstream. The structure has the same gate type as the existing intake diverting water to Azua area. Considering the required discharge of 30 m^3/sec at the period of peak water demands, the structure will be equipped with three sluice gates having spans of 1.83 m and height of 2.5 m. Besides the existing intake gates and the sand flushing gate will be replaced with new gates, which are operated by both electric motor and manually.

172. The Santana headworks is to be used as a headworks for the proposed main canal as well as the existing Santana canal. The existing intake and sand-flushing sluice are to be

totally replaced with new ones. The overflow section will be remained as it is. The gates are operated by both electric motor and manually.

173. For the proposed main canal, reinforced concrete flume type is adopted in the reaches of about 1.3 km from the Santana headworks to the inlet of the siphon No.1, which is a crossing structure under the Yaque del Sur River. The main canal, in the other than the first reaches, will be of concrete-lining canal having a trapezoidal cross section. The primary features are shown below:

- Design discharge: 7.2 m3/sec – 0.47 m3/sec
- Design velocity : 1.45 m/sec – 0.53 m/sec

174. A flood protection dike is proposed in parallel to the main canal in the same reaches as the concrete flume works from the Santana headworks to the inlet of the siphon No.1.

175. Siphon structures are to be provided on the main canal crossing the Yaque del Sur River and crossing the depression at Canoa, which becomes a flood way of the Yaque del Sur River. The design discharges are 6.4 m^3/sec and 4.6 m^3/sec, respectively. The total length is about 700 m for No.1 and. about 250 m for No.2.

176. 10-night storage pond will be provided. The required storage capacity is determined on the assumption that the pond stores irrigation water of 12 hours supposing the outflow of 12 hours against the inflow of 24 hours at the time of the peak irrigation requirement of 1.2 l/s/ha.

177. If all the pump stations are operated simultaneously during the drought period when the river water is small, water becomes short and pump stations located in the most downstream easily draw sea water. During this time, it is the most effective to continuously and constantly pump water for 24-hours to meet the river flow. It needs rotation of pump operation among pump stations. Some of the pump stations have to be operated during night time. Meanwhile, irrigation should be practiced during daytime. In order to fill the gap between the pump operation and the irrigation practice, a night storage pond should be provided. Against the interruption of electricity, which frequently occurs, the pond is effective. Storage capacity is determined to be able to store the amount of water corresponding to 12 hours of peak irrigation water requirement (1.2 lit/sec/ha). The regulation ponds will be structurally almost similar to the night storage ponds to be provided in the gravity irrigation system.

178. Water supply from the night storage pond is to be limited during daytime or the time when farmers are working in the fields from the view of efficient use of water. The existing laterals and sub-laterals need twice as much as present flow capacity. Most of the laterals and sub-laterals are earth canal at present. These canals will be, therefore, improved with the provision of concrete lining or wet stone masonry for mainly increasing the canal capacity. Some of the existing canals, which are excessively deep and much meandering will be replaced by newly constructed canals. Field canals will be improved with the slope trimming and repairing the embankment.

179. Inspection roads will be provided for operation and maintenance of the main canal and laterals in the reaches where a road is not available. The inspection road will be 5 m to 6 m in width.

180. Work volume of the irrigation facilities plan is 1.31 million m^3 of earthwork, 38,000 tons concrete, 19 gates and 790 related irrigation structures.

Plan of Setting up and Strengthening Water Users' Organization (WUO)

181. The main objective of WUO is placed that beneficiaries themselves operate and maintain the irrigation and drainage facilities. In addition, WUO is expected to play a role as a communication channel for farming management especially for mobilization of tractors and distribution of farm inputs like fertilizer and pesticide.

182. INDRHI should take charge of the operation and maintenance of the Santana headworks as well as the Villarpando headworks, since the Santana is related to both CEA and the Project. WUO should share a responsibility for operation and maintenance for all the irrigation and drainage facilities except the Santana headworks in the future, provided that INDRHI should share a large scale repairing works. Most of the irrigation systems such as the main canal, night storage ponds, pump stations, and lateral and sub-lateral canal systems will be actually operated and maintained by work forces consisting of technical and management staffs employed by WUO.

183. WUO will be composed of the hierarchy of nucleuses, sub-committees, associations, and an irrigation committee in accordance with the irrigation system levels. All the farmers in the Project area should be members of the WUO. The number of nucleuses is around 200. Each nucleus has a little over 20 and a little less than 30 ha..

    The General Assembly, as the higest authority will be held usually twice a year. The Board of Directors is responsible for the management and administration of the Irrigation Committee and employ and manage technical and administration staff that are the actual work force for operation and maintenance of irrigation and drainage facilities. The associations and the sub-committees watch the work force at the respective level. The main duties of the nucleus are to make irrigation rotation schedule among fields, and to operate and maintain field canal systems.

Operation and Maintenance of Irrigation Facilities

184. The Irrigation Committee will employ technical and management staff who actually assist WUO to prepare maintenance programs, irrigation schedules and directly carry out O&M in the conveyance systems including the proposed night storage ponds and administrative management including collection of water.

185. WUO needs office space and light equipment and tools for the water management and routine operation and maintenance works. The Irrigation District Office should add a dump truck, a motor grader, a backhoe and a bulldozer in addition to the present force of equipment.

186. The O&M costs are estimated at least DR$6.7million/year for whole the WUO in the Project. It is equivalent to DR$1,100/ha including O&M of overall water management. This cost, however, does not include the costs of large scale repairing by heavy construction equipment and an allotment to INDRHI.

Water Charge

187. As for the price of water charge, it is appropriate that the water charge is DR$. 1,100 /ha/year in consideration of the O&M costs, farmers' intention, and farmers' capacity to pay with Project condition. Many of farmers have a sense that the water charge of DR$.1,100/ha/year is not expensive, if the irrigation water management is properly practiced. Also, farmers will have a sufficient capacity to pay it with Project condition. It is proposed for the initial stage of the Project to simply determine the water charge in proportion to the agricultural land owned by each of farmer irrespective of both the kinds of crops (except paddy) and the planting area of crops. A nucleus chief and a treasurer will collect the water charges from the member farmers and pay the collected money into

the bank account of WUO. In order to expedite the payment of water charge, it is recommended to include some punishment for non-corrected charges and incentive in by-laws.

188. The following process will be taken for newly setting up WUO. In order to fulfil the institutional development works, the Project will form a Division composed of an institutional expert, organizers, operation and maintenance experts of irrigation facilities, as well as others. One organizer and one assistant who will be selected from the leading farmers in the target area will form a team and will work at the front line to organize the farmers. Manpower required for the field activities is estimated at five (5) organizers and five (5) assistants on the assumption that organization is completed for four years. Total manpower required for the setting-up and reinforcing WUO is estimated about 700 M/M including an institutional expert, operation and maintenance experts, and water management experts.

RURAL INFRASTRUCTURE PLAN

Rural Water Supply Plan

189. 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.

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 its water source on the Yaque del Sur River. 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 1) pump, 2) settling pond and filtration gallery, 3) chlorinating, 4) elevated water tank, and 5) gravity distribution system with PVC pipe line. 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 below. Hydraulic design of pipeline system is based on the Hazen-Williams formula and conveyance head loss is estimated at 30%.

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"

Community Center Plan

190. 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. 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

Plan of Environmental Conservation

191. The objectives of this Project are: in case of the flood, 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 where 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. It is around 1.2 kms long. A small recreation area is established also in the right bank near the bridge which is very accessible place from both Tamayo and Vicente Noble. Concerning facilities required, a maintenance road along the green belt is constructed. The road is also used as a walk way for 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.

Environmental Monitoring Program in Rincon Lagoon

192. The objectives of this Project are: to collect basic data in long term 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.

PLAN OF OPERATION AND MAINTENANCE

Overall Water Management

193. The inspection works for overall mater management are conducted in three ways, namely (a) daily inspection, (b) periodical inspection, and (c) detailed inspection. 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, a chart of inspection schedule 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.

194. The operation will be started 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. Field canals and drains will be maintained by farmers themselves of every nucleuses as a communal work. The maintenance works are carried out twice 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 repairing is required, the Irrigation District Office will assist WUO mobilizing heavy construction equipment.

195. 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 as same as 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, and so on. 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. Water charge to INDRHI will be paid following the agreement between INDRHI and INAPA. Collection of water charge 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 office.

196. 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.

Environmental Conservation

197. The Project, which requires maintenance, is "Green Belt Formation for Waterfront Conservation". For the planted bamboo and shade trees, the maintenance for 6 months is required. After the 6 months, since the bamboo is tall enough to win competition with weeds, any more cares are not required.

IMPLEMENTATION PLAN AND ORGANIZATION

Implementation

198. The Project covers sub-Projects with different components in works. 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 beneficiaries' participation for construction and operation and maintenance.

199. It is planned that implementation period is set at 5 years taking into account the content of works, scale of works, available working days, and so on for the sub-projects. The Project will be performed in two steps: phase-1 and phase-2. Phase-1 is composed of (i) Improvement of Villarpando headworks, which should function fair delivery of river water to Azua irrigation district area and Yaque del Sur/Lago/Enriquillo irrigation district, (ii) Construction of a Yaque del Sur water management center building and installation of urgent communication equipment, (iii) Improvement of Santana headworks and improvement for irrigation facilities of the irrigated land on the right side of the Yaque der Sur River (Tamayo irrigation system:about 600 ha), (iv) Strengthening and fostering of water user's organization, (v) Preparation of cadastral maps of the irrigated land and provision of services for farmers to get definite land title, (vi) Reinforcement of market information, and (vii) Detailed design for irrigation facilities for the remaining area. Phase-2 is composed of (i) Improvement of irrigation facilities for remainder of the irrigated land, (ii) Strengthening and fostering of water user's organization for

remainder of the irrigated land, (iii) Preparation of cadastral maps and provision of services for farmers to get definite land title, (iv) Installation of remaining communication equipment and training, (v) Design and Construction of rural water supply systems, (vi) Design and Project for strengthening research and extension services, (vii) Continuous operation of market information system project, and (viii) Design and Construction Environmental conservation project.

Cost Estimate

200. The total cost of the Project is summarized below:

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 Villarpando headworks*	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

Fund Requirement

201. The annual disbursement schedule for the project execution is worked out based on the implementation schedule and price escalation factor (domestic currency: 15%, foreign currency 2%) and fund requirement is DR$1,196 million

Operation and Management Cost

202. The annual O&M cost in the full operation stage for the respective projects is summarized below:

Project	The total O&M cost			O&M cost for the project area	
	Administration cost (1,000 DR$)	O&M of facilities (1,000 DR$)	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 Villarpando headworks	-	10	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

Replacement Cost

203. 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 at 20 years after commencement of the project.

PROJECT EVALUATION

Economic Evaluation

204. The economic feasibility is first evaluated by calculating the Internal Rate of Return (IRR). In the economic evaluation, costs for agricultural support projects containing research/extension projects, credit project and agricultural cooperative/information

center project and environmental conservation projects were not taken consideration. Sensitivity analysis was carried out to evaluate the soundness of the Project against possible adverse changes in the future for the cases of (i) Cost overrun by 20%, (ii) reduction of irrigation benefit by 20% due to decrease of crop yields and prices, and (iii) combined effect of cases (i) and (ii). The results are shown below.

Case	Internal Rate of Return(%)
Original	23.0
(i)	20.0
(ii)	20.1
(iii)	16.9

Financial Analysis

205. In order to evaluate the Project from the financial aspect of the farmers, the farm budget analysis on different sizes of farmers is made under both futures with and without Project conditions. After the implementation of the Project, the Project will provide bases for introduction of improve 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 be much improved, 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:

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

Socio-Economic and Environmental Assessment

206. In addition to the direct benefits counted in the project evaluation, various secondary and intangible benefits and favorable socio-economic impacts are expected. The result of the EIA points out the several positive impacts to socio-economic condition caused by the projects concerning irrigation facilities and WUO. This does not simply mean that more agricultural production and higher income are brought to local farmers, but that changes of essential structure or characteristics of the rural society are also 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. In the Project area, it is also expected that same kind of changes will occur, which are concretely:

(1) All users will elect leaders such as water distributor of organization. As a result, a more democratic rural society will be built,

(2) Organization with stratum structure, consisting of nucleus, committee and association, will be built. As a result, the power will be decentralized and the water management will be performed more efficiently and democratically,

(3) In every level of the organization, the decisions wii be made through discussion among water users. As a result, the decision process will become more democratic, and user's consciousness of social participation will become higher,

(4) Collaborated works for the irrigation facility management will be done by all users. As a result, user's consciousness on social participation will increase, and

(5) Through formation of WUOs, a sense of solidarity of the farmers will be strengthened so that a agressively independent rural society will be created. As a result, the present privilege power will be decentrarized and rural farmers will have power. It is expected that present rural society will become more democratic,more fair and more public.

207. In addition, through the Project implementation, (1) Increase in employment opportunity and technical transfer, (2) Quality improvement of the farm products, (3) Improvement of the nutritional status of the rural population, (4) Improvement of the present water supply condition, (5) Improvement of local transportation, and (6) Energy aspect are expected.

Environmental Impact Assessment (EIA)

208. The result of the Initial Environmental Examination (IEE) points out some possible negative impacts by the Project implementation. In agricultural development projects, however, negative impacts do not necessarily always happen. Since the Project does not provide a large construction works, it is friendly enough for the environment, and brings many positive impacts. Through the IEA, no serious negative impact has been assessed in this Project.

Overall Assessment for the Project

209. The Project is technically sound and economically feasible, being IRR 23%. Moreover, the Project will provide substantial and sustainable socio-economic benefits not only within the Project area but also within 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 areas do not have components with big 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 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 psychically rich society with empowered people.

Conclusions and Recommendations

210. The agricultural development in the lower Yaque del Sur River including rehabilitation of Villarpando headworks should be integrated with the following points for success:

(i) Improvement of irrigation facilities such as Villarpando headworks and the existing irrigation facilities will be improved

(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) Constructions 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

211. 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 opportunity for local people and improvement social welfare.

212. It is recommended based on 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 Villarpando headworks and the Yaque del Sur Water Management Center Project should 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 undertook beforehand. 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 Tamayo irrigation system will be done. Also cadastral ledger and legal services on land registration will be provided with relevant farmers. Based on the results of the Phase-1, the Project should be smoothly and efficiently performed.

213. 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 should be carried out to design flood discharge delivery

THE STUDY
ON
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THE YAQUE DEL SUR RIVER BASIN
IN
THE DOMINICAN REPUBLIC

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ACRONYMS AND ABBREVIATIONS

AGLIPO	Project Aguacate Limon y el Pozo
Asentamiento	Agrarian Reform settlement
BAGRICOLA	Banco Agricola (Agricultural Bank)
BID	Banco Interamericano de Desarrollo (Inter-American Development Bank)
CAASD	Corporacion de Acueducto y Alcantarillado de Santo Domingo (Santo Domingo Water Supply and Sewerage Corporation)
CADER	Centro de Administración del Desarrollo Rural (Center for Administration of Rural Development)
CDE	Corporación Dominicana de Electricidad (Dominican Electric Corporation)
CEA	Consejo Estatal de Azúcar (Governmental Sugar Council)
CEDOIS	Centro Dominicano de Organizaciones de Interés Social (Dominican Center for Organizations of Social Concern
CESDEM	Centro de Estudios Sociales y Demograficos (Center for Demographic and Social Studies
CEVEMA	Centro de Venta de Materiales Agripecuaris (Agricultural Input Sub Centers)
CIAS	Centro de Investigación Agropecuaria de San Juan (Agricultural Research Center in San Juan)
CIAZA	Centro de Investigaciones Agricola en Zonas Aridas
CIDA	Canadian International Development Agency
COEE	Emergency Reservoir Operation
CORAASAN	Corporacion de Acueducto y Alcantarillado de Santiago (Santiago Water Supply and Sewerage Corporation)
DEFINPRO	Central Bank's Department of Financing
DDR	Departmento Distritos de Riego (Irrigation District Department)
DGF	Dirección General Forestal (General Forestry Directorate)
DNP	Dirección Nacional Parque (National Parks Directorate)
DR	Dominican Repulbic
FAO	Food and Agriculture Organization of the United Nations
FDA	Fundación Para el Desarrollo Agropecuario (Agricultural Research Fundation)
FDD	Fundación Dominicana de Desarrollo (Dominican Foundation for Development)
FED	Fondo Europeo de Desarrollo (Europian Development Fund)
FEPROCA	Federación de Productores Campesinos (Federation of Farmers in Azua)
FTZ	Free Trade Zones
FUDECO	Fundación Para el Desarrollo Comunitario (Foundation for Community development)
FUNDASUR	Foundation for the Development of the South
GDP	Gross Domistic Product
GTZ	German Society of Technical Cooperation
IAD	Instituto Agrario Dominicano (Dominican Agrarion Institute)
IBRD	International Bank for Reconstruction and Development
IDB	Interamerican Development Bank
IFAD (FIDA)	Fondo Internacional Para el Desarrollo Agricola (International Fund for Agricurtural Development
IICA	Inter-American Institute for Agricultural Cooperation
IMF	International Monetary Fund
INAPA	Instituto Nacional de Aguas Potables y Alcantarillados (National Institute of Potable Water and Sewerage)
INDESUR	Instituto para el Desarrollo Del Suroeste (Institute for the Southwest Development)
INDOTEC	Instituto Dominicano de Tecnologia Industrial (Dominican Institute of Industrial Technology)
INDRHI	Instituto Nacional de Recursos Hidraulicos (National Institute of Hydraulic Resources)
INESPRE	Instituto Nacional de Estabilizacion de Precios (Price Stabilization Institute)
INPOSDOM	Instituto Postal Dominicano (Dominican Postal Institute)
IPM	Integrated Pest Management
ISA	Instituto Superior de Agricultura (Superior Institute for Agriculture, ISA)
JAD	Junta Agroempresareal Dominicana (Dominican Agribusiness Council)

JICA	Japan International Cooperation Agency
Juntas de Regantes	The highest level of water user organizaton: a grouping of Irrigation Associations
Junta Directiva	Board of Directors of the Junta de Regantes
MCM	Million Cubic Meter
NGO	Non-governmental Organization
nucleo	Lowest-level organizational unit in the Junta de Regantes, usually consisting of farmers sharing a single turnout
OEA (OAS)	Organización de Estados Americanos (American States Organization)
OFWMP	On-farm Water Management Project
ONAPLAN	Oficina Nacional de Planificación (National Planning Office)
ONAMET	Oficina Nacional de Meteorologia (National Office of Meteorology)
OTTT	Oficina Técnica de Transporte Terrestre (Technical Transportation Office)
PLANAR	Plan Nacional de Agua Rural (Rural Waterway National Plan)
PLANIACAS	Plan Nacional de Investigafon, Aprovechamiento y Control de Aguas Subterráneas (National Plan of Study, Use and Control of ground Water)
PLANDZF	Plan Nacional de la Zona Fronteriza (Border Zone Development Plan)
PMF	Probable Maximum Flood
PRISA	Programa Integrado de Salud en el Suroeste (Intergrated Local Program in the Southwest)
PROFAMILIA	Asociación Dominicana Pro Bienestar de la Familia (Family Welfare Office)
PROSEMA	Programa de Servicios de Maquinarias Agricolas (Agricultural Machines Service Program)
PRODAS	Proyecto de desarrollo Agricola en San Juan dela Maguana (San Juan de la Maguana Agricultural Development Project)
PROMAF	Projcto Manejo de Aguas a Nivel de Finca (On-farm Water Management Project)
PROMASIR	Programa de Mejoramiento y Administracion de los Sistemas de Riego
PROMATREC	Projecto de Manejo deTierras Regadas y Cuenca
SCF	Standard conversion factor
SEA	Secretaria del Estado de Agricultura (Ministry of Agriculture)
SEEC	Secretaria de Estado de Education y Cultura (Secretary of State Education and Culture)
SEOPC	Secretaria de Estado de Obras Publicas y Comunicaiones (Secretary of Public Works and Communication)
SESPAS	Secretaria de Estado de Salud Pública y Asistencia Social (Secretary of State Pubic Health and Social Assistance)
SINACAR	Sistema Nacional de Capacitacion de Asociaciones de Regantes
SINAPBRI	Sistema Nacional Autogestionario de Producción Bajo Riego
SSID	Servicio Social de Iglesias (Dominican Churches Social Services)
SURENA	Subsecretaria de Estado de Recursos Naturales (Subsecretary of Natural Resources)
tarea	Measure of land, 0.063 hectares
toma	Turnout
UASD	Universidad Autonoma de Santo Domingo (Authonomus University of Santo Doming)
UNPHU	Universidad Pedro Henriquez Urena (University Pedro Henriquez Urena).
USAID	United States Agency for International Development
WHO	World Health Organization
WMO	World Meteorological Organization
WTO	World Trade Organization
WUO	Water User Organization
YSURA	Yaque del Sur-Azua. Irrigation system serving Azua Valley

CURRENCY EQUIVALENTS

US $1 =Dominican Peso 14.0 = Japanese Yen 126
as of February 1998 (Master Plan Study)
US $1 =Dominican Peso 15.5 = Japanese Yen 112
as of January 1999 (Feasibility Study)

1. INTRODUCTION

1.1 Authority

This is the report which the JICA Study team prepared in accordance with the Scope of Work (S/W) for the Study on the Integrated Rural Development Project of the Yaque Del Sur River Basin in the Dominican Republic (the Study) agreed upon between the Government of the Dominican Republic (GORD) through the National Institute of Hydraulic Resources (INDRHI) and the Japan International Cooperation Agency (JICA) in July 2nd 1997.

1.2 Background of the Study

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

The Study area is categorized into the poorest region with serious high unemployment rate. There are no development resources other than agricultural sector. The agricultural development, therefore, has been the only means for uplifting income and living condition in the Study area. However, agricultural production in the area is low and unstable due to severe drought and insufficient water resources. Furthermore, agricultural support services are under developed, which becomes one of serious factors to hamper agricultural development and attribute to low farm income. The Dominican Government gave the high priority for the agricultural development of the Yaque del Sur River Basin to improve living standard and public wealth of the people.

Under such circumstances, the Dominican Government requested the Government of Japan in October 1996, to formulate a Master Plan on an integrated rural development project in the Yaque del Sur river basin and to conduct a feasibility study of the priority development area. In response to this request, the Government of Japan dispatched a preparatory study team during June to July 1997 and has a series of discussions with the Dominican Government on the Scope of Work for the Study on the Integrated Rural development Project of Yaque del Sur River Basin that was agreed between INDRHI and the Government of Japan.

1.3 Objectives of the Study

The objectives of the Study are (1) to prepare a Master Plan on an integrated rural development project of the Yaque Del Sur river basin of which components shall include

water resources development and agricultural and rural development, (2) to conduct a feasibility study of priority areas selected in the Master Plan and (3) to transfer technology, which is used for this study, to the Dominican Republic counterpart personnel through on-the-job training in the course of the Study.

1.4 Performance of the Study

The Study was carried out in two phases. The Phase-I Study was carried out from November 1997 to June 1998. In this period, the following study was conducted: (1) assessment for the present conditions in the whole basin of the Yaque del Sur River, (2) preparation of master plan of an integrated rural development of the Yaque del Sur River Basin and (3) selection of the high priority area for the feasibility study. The reports submitted to the Dominican Government by the JICA study Team were as follows:

(1) Inception Report on November 18, 1997

(2) Progress Report-I on March 2, 1998

(3) Interim Report on July 9, 1998

All the results of the Phase-I Study were compiled in the Interim Report.

The Phase-II study was conducted from March 1998 to March 1999. The meeting was convened to explain and discuss the Interim Report on 9, 1998. The contents of the report were explained by the JICA Study Team and accepted by the Dominican side. The minutes of the meeting on the Interim report were prepared and signed between both sides. Based on the agreement, the feasibility study for the high priority area was conducted. The Progress Report-II including assessment of the present conditions in the high priority area and preliminary development plans was submitted to the Dominican Government on January 1999 after the completion of the field survey. Then, the Final Draft Report, which contains all the results of the master plan and the feasibility study, was prepared.

In principle, the Study was carried out by the joint efforts of the JICA Study Team and the counterpart personnel assigned from the Dominican Government. The Team transferred technical knowledge to the counterpart personnel through the day-to-day operation of the Study in the field. Throughout the study course, a series of regular meetings were held once a week at the office of INDRHI to exchange views on the Projects. Besides, technical knowledge transfer in Japan was performed for three counterpart personnel as follows:

Mr.Jose Ogando Montero, Agronomist	June 3 – 25, 1998
Mr. Sergio Jose Tejada, Irrigation engineer	Feb. 9 - March 4, 1999
Ms. Mayra A. Sanchez Santana, Hydrologist,	Feb. 9 - March 4, 1999

The counterpart personnel and the JICA experts who took part in the Study are shown in Table 1.

2. PROJECT BACKGROUND

2.1 General Economic Conditions in the Dominican Republic

The population of the Dominican Republic was estimated at 7.89 million in 1998. 45 % of the population live in rural area. Urbanization was rapidly proceeded and 2.4 million people live in Santo Domingo, the capital. The unemployment rate was estimated at 18 %. Agricultural sector contributes to 12.7 % of GDP and provides employment for 14 % of the total economically active population in the country. About 50 % of the country's total export come from the agricultural sector, which indicates that the Dominican Republic is still an agricultural country.

Since 1990 the Government has undertook a new Economic Program that combined stringent stabilization measures and unification of foreign exchange market with financial system, trade, pricing and tax reforms. The growth has turned positive from 1994 and real GDP growth was estimated at 5 % in 1997. Per capita growth averaged 4 % during 1994-1997 period. Inflation rate has been very low achieving a record low of 3.95 % in 1996.

Because of promoting growth of free zones and the array of government interventions that introduced price distortion and reduced the sector competitiveness, the country has to import significant amount of food stuff to satisfy domestic demand. The main imported foodstuff are wheat, corn, dairy products, sorghum, milk, cooking oil, rice and red beans, being equivalent to US$535 million (17% of total imports).

2.2 National Development Policy

In August 1996 the new administration explained the country's social and economic development strategy based on six broad objectives:

(1) To achieve a sustained annual GDP growth of 7-8%;

(2) To strengthen an economy based on the private sectors and oriented towards foreign trade;

(3) To keep an inflation rate of below 10 % a year;

(4) To keep a financial equilibrium of the consolidated public sector, a rational Government expenditure and an increase in taxes to 20 % of GDP;

(5) To increase (double) Government spending in social expenditure giving greater emphasis to health services, social security and also to basic technical and vocational education and;

(6) A Government fundamentally dedicated to facilitating a competitive economy, to ensure investment in infrastructure and putting into effect an integrated strategy to improve equity and eradicate poverty.

In order to achieve those goals, the Government set an agricultural policy as follows:

(a) Agricultural Production:

- Promote food production to achieve self-sufficiency on the main staple food (rice, red beans, plantain and cassava)
- Promote productions of traditional and non-traditional export crops to increase foreign exchange earning.
- Enhance the level of agricultural production from small farms and increase their level of income.

(b) Marketing and Price Policies

- Promote the elimination of all tariff and non-tariff barrier to domestic agricultural production and trade.
- Promote trade liberalization and market access for agricultural commodities.
- Reduce price controls on both agricultural inputs and final goods and keeping some price intervention for some sensible crops.
- Promote private initiatives that would strengthen domestic agricultural markets.

(c) Credit Policy

- Increase credit access to the agricultural sector through budgetary allocation to the Agricultural Bank and the Reserves Bank
- Continue credit support to the main food crops (especially rice) to the agrarian reform settlement and small farmers.

(d) Land Reform Policy

- Provide Land Reform Settlers with definite titles to increase their capacity to obtain credit.
- Consolidate and strengthen settlements support services on production, infrastructure and market development.

(e) Irrigation Policy

- Increase investment on irrigation facilities and maintenance of the existing facilities.
- Improve irrigation system management by extending and increasing water charges and transfer of the irrigation system to water users.
- Promote the enactment and implementation of the National Water Code
- Promote a new legal and institutional arrangement for the management of major river basins.

(f) Natural Resource Policy

- Promote recuperation and protection measures to prevent soil erosion .
- Encourage crop zoning according to soil quality and water availability
- Adopt a holistic approach on watershed management putting more attention to agricultural production systems and the needs of small farmers.

(g) Research and Extension Policy

- Promote coordination between research and extension systems.
- Promote efficient management mechanism of Agricultural Research Centers decentralizing their operation and incorporating the private sector and farmers.

2.3 Regional Development in the Basin of the Yaque del Sur

The Yaque del Sur River Basin (the Study Area) is located in the Southwest region, the least developed part of the country. The highest concentration of poverty persists in the southwest. According to the Study "Focalizacion de la Pobreza en la Republica Dominicana" (Focusing on Poverty in The Dominican Republic), the Region comprises the highest % of poor household with more than 75% living in poverty. Similarly 55 % of the population earn less than DR$750 a month and 24 % between DR$750 and DR$1,000 in 1993. The Government has identified that region has the top priority for the regional development to reduce poverty and regional imbalances.

Bahoruco, Azua, San Juan and Barahona, which are the main provinces in the Study Area, are among the provinces with the highest level of poverty in the Southwest region. Also living environmental conditions are one of the poorest.

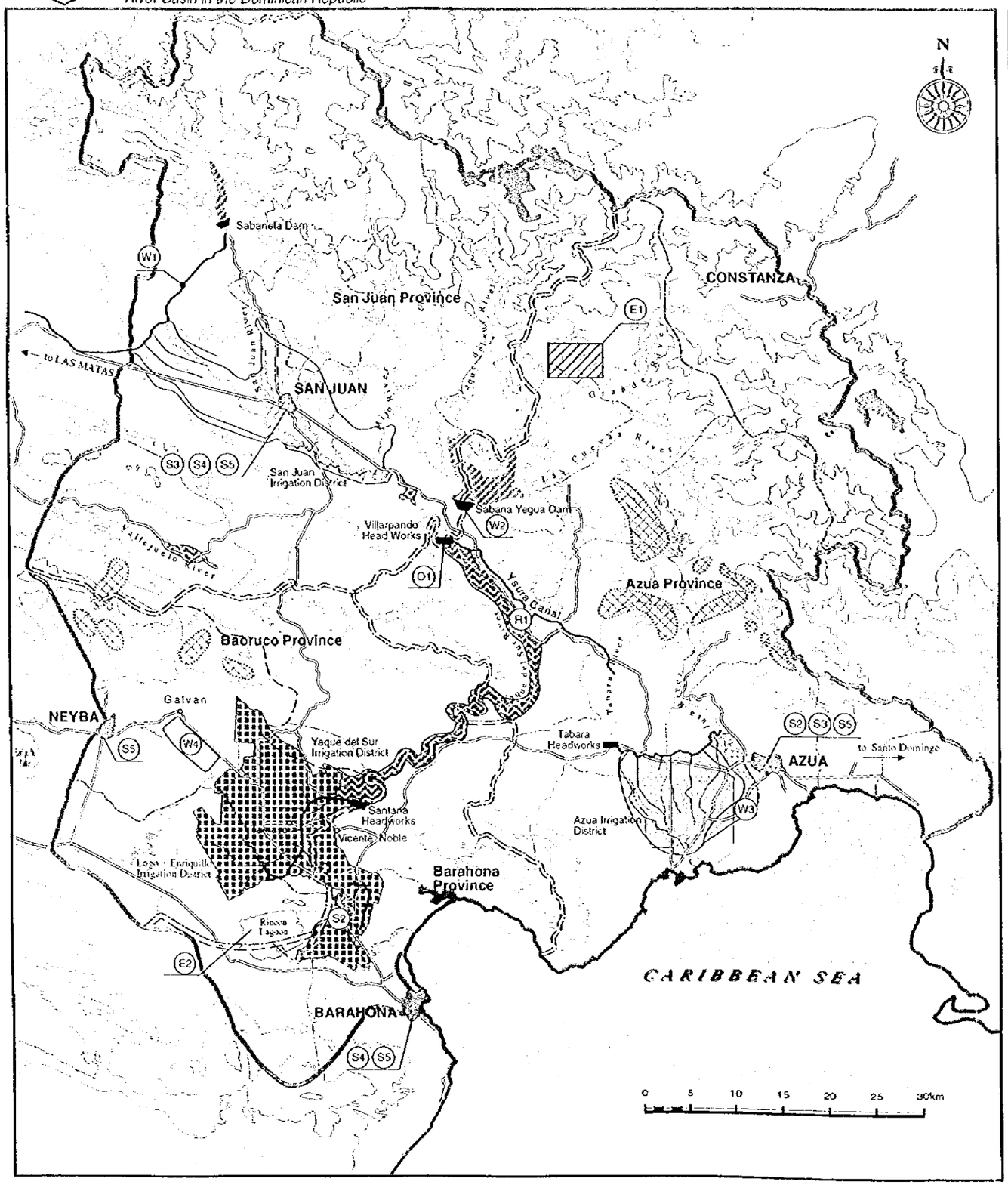
PART 1 :

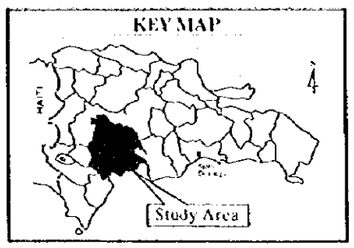
MASTER PLAN STUDY ON THE AGRICULTURAL DEVELOPMENT IN THE YAQUE DEL SUR RIVER BASIN

JICA

The Study on Integrated Rural Development Project of Yaque del Sur River Basin in the Dominican Republic

General Development Plan in the Yaque del Sur River Basin





LEGEND

- Boundary of Project Area
- Irrigation District Boundary
- Provincial Boundary
- Municipality Boundary
- Road
- Canal
- Village
- Dam
- Headworks
- River
- Contour

Agriculture

1 : Coffee Production Improvement Project (7,200ha)

Agricultural Support

1 Whole Area : Plan for Credit Services (Rural Development Fund & Fund for the Rural Poor)
2 (S2) : Plan for Strengthening CIAZA Research Center
3 (S3) : Plan for Seed Multiplication
4 (S4) : Plan for Strengthening Extension Services
5 (S5) : Plan for Market Information Systems
6 Whole Area : Plan for Agricultural Cooperatives

Overall Water Management in Yaque del Sur River Basin

1 (O1) : Plan of Yaque del Sur Water Management Center

Irrigation and Drainage

1 : Night Storage Pond Project (20,961ha)
2 : Guanito San Juan Irrigation System Improvement Project (1,000ha)
3 : YSURA Area Irrigation Improvement Project (7,732ha)
4 : YSURA Extension Area Development Project (2,275ha)
5 : YSURA Headrace Small Irrigation System Improvement Project (1,100ha)
6 : Yaque del Sur Lower Reaches Irrigation and Drainage Project (20,000ha)
7 : Galvan Groundwater Irrigation Project (540ha)
8 : Yaque del Sur Small Gravity Irrigation System Improvement Project (7,500ha)
9 Whole Area : Plan of Strengthening Water Users Association

Rural Infrastructure

1 (R1) : Magueyal Mini-Hydropower Project
2 Whole Area : Rural Water Supply Plan
3 Whole Area : Rural Road Improvement Plan
4 Whole Area : Other Social Infrastructure Improvement Plan

Environment

1 (E1) : Reforestation Plan in the Upper Watershed Area of Grande River (Model area:3,000ha)
2 (E2) : Wildlife Conservation Plan in Rincon Lagoon

Water Resources

1 (W1) : J.J. Puello Dam Development Project
2 (W2) : Sabana Yegua Dam Rehabilitation Project
3 (W3) : Azua Groundwater Development Project
4 (W4) : Galvan Groundwater Development Project

3. THE PROJECT AREA

3.1 Administration and Socio-Rural Conditions

3.1.1 Administration and Areas

The Study area is about 7,100 km^2 or 14 % of the, total area of the whole country. Administratively, the Study area is under the full or partial jurisdiction of two regions, 6 provinces, 29 municipal districts and 150 rural sections. Rural sections are the most basic subordinate organization in the community. Each province has a local capital with local government and main public offices. The total population of the Study area was estimated at 833,000 in 1998 or about 10 % of the country population. The total number of households is estimated at 145,200. The average family size is 4.28. The population growth rate is 1.5%. The population density is very low with 87 person/km^2.

3.1.2 Land Tenure

Since 1962 the Government began a process of land distribution among landless peasants. At that time the Dominican Agrarian Institute (IAD) was created by Law to manage the land settlement program.

Land ownership is highly concentrated in the Study area. Information from the Agricultural Census of 1981 shows that around 85% of the farms owns less than 80 tareas (5 ha) with an average size of one. In the Study area, there has been more land fragmentation.

3.1.3 General Information of the Sample Households

To collect useful information from the Study area a household survey was conducted among 150 farmers spread out among 13 communities of 4 provinces of the Study area.

Most farmers have lived in the area for more than 25 years. The average farmer is 46 years old with an average of 35 years as a farmer. The average household consists of 5 members including the spouse and children and headed mostly by a male (95%). Regarding education, 43% of farmers only achieved a primary level and 17% is illiterate. However, only 22% of the farmers interviewed went to secondary school and university.

In regard with the type of housing, only 9.3% of the household live in good housing with cement walls and ceilings. Most of the houses are made of wooden walls and tin roofs (41%). Regarding drinkable water, 69% of the farmers interviewed did not have access due to lack of aqueducts at the villages. Most of the farmers use Liquid Petroleum Gas (LPG) to cook meals (82%) and only 15% use fuel and charcoal. About 74 % of the farmers have access to electricity although there is some power shortages during the day.

About 93% of total incomes of the farmers depends on source of crop income. In Azua area, the farmers earn their income from sale of plantain, banana, tomato, sweet potato and cassava. In San Juan area, the farmers earn their income from sale of rice, red beans,and sweet potate, in Barahona and Baoruco area from plantain, banana and cassava. They have few income from livestock activities. While 10% of the total income is derived from from such activities as working in other farms, as employee of public or quasi public

enterprises and engaging in commercial activities. Some farmers receive remittances from relatives living outside of their village. In fact 18.7% of the farmers respondents received remittances from relatives in Santo Domingo, the United States and Spain in 1997. They consume 50% of their living expenses for food.

The farm budget of an average irrigated farmer in each province is summarized below:

item	Azua Province	San Juan Province	Barahona, Baoruco Province
Family member	5	4	5
Average farm size (ha)	1.73	3.48	1.7
Agricultural income (peso)	74,030	90,010	55,390
Income outside of agricultural activites (Pesos)	10,000	10,500	12,800
Total income (peso)	84,030	100,510	68,190
Production cost (peso)	21,430	48,700	20,350
Living expenses (peso)	55,480	48,550	45,460
Total expenditure (peso)	76,910	97,250	65,810
Surplas (peso)	7,120	3,260	2,380
Engel' coefficient (%)	51	53	54
Monthly per capita living expense (peso/person)	930	1,010	760
Monthly per capita surplas (peso/person)	120	70	40

It may be concluded that most of the irrigated farmers in the basin remain at subsistence level of living. It is considered that the farmers under rainfed condition remain at more serious subsistence level of living.

3.2 Natural Conditions

3.2.1 Land Resources

(1) Soils

The soils in the Study area are classified into 18 soil associations according to the soil map prepared by the Organization of American State in 1967. The area of each soil association is shown below and its distribution is illustrated on Figure 1.

Name of soil association	Area (km^2)	Proportional extent (%)
Valle Nuevo	34	0.4
San Juan Hatico	136	2.0
Quita Coraza	574	8.0
Azua Plata	426	6.1
Elias Pina-Las Matas	9	0.1
La Jina-Yuma	514	7.2
Los Bucaros	165	2.4
Cacheo	259	3.7
Guama	451	6.3
Constanza	31	0.4
Guanita	2	-
Guanito Villarpanda	216	3.1
Yabonico	55	0.9
Suelos Aluvales Recientes	417	5.9
Cinagas Costera e Interior	65	1.0
Playa Costera y Dunas	6	0.1
Terreno Escabroso no Calizo and Calizo	3743	52.0
Lake and Lagoon	29	0.4
Total	7,100	100.0

(2) Land Capability

Land capability classification study for the entire country was made by the Organization of American States in 1967, following the classification system of USDA. The extent of lands of the Study area assessed by this land capability classification is shown in the following table and land capability map is illustrated in Figure 2.

Land capability classes are numbered from one to eight. Classes 1 through 4 can be used for cultivation; Classes 5 through 8 cannot be cultivated in their present state under normal soil management. The result of land capability classification in the Study area indicates that 24.6% of the area or 1,750 km^2 is able to be used for cultivation.

Land capability classification	Definition of class	Area (km^2)	Proportional extent (%)
Class-1	Class-1 soils can be used continuously for intensive crop production with minimum attention other than good farming practices.	0	0
Class-2	Class-2 soils have more limitation than Class-1 soils for intensive crop production, such as moderately steep slopes(2-5%).	465	6.5
Class-3	Class-3 soils have severe limitations and require more special conservation practices than Class-2 soils to keep them continuously productive. They have shallow soil, steep slopes of about 6-10% or shallow water tables.	860	12.1
Class-4	Class-4 soils have severe limitations and need a greater intensity of conservation practices for cultivated crops than Class-3 soils. Most of the time these soils should be in "permanent" crops, such as pastures	425	6.0
Class-5	Class-5 soils are not likely to erode but have other limitations, such as boulders or wetness, which are impractical to correct and thus cannot be cultivated. They should be used for pasture, range, woodland, or wildlife habitat.	565	8.0
Class-6	Class-6 soils are suitable for the same uses as Class -5 soils, but they have a greater need for good management to maintain production because of such limitations as steep slopes or shallow soils.	680	9.6
Class-7	Class-7 soils have very severe limitations and require extreme care to protect the soil, even with low intensity use for grazing, wildlife, or timber	4,035	56.8
Class-8	Class-8 soils have such severe limitations (steep slopes, rock lands, swamps, delicate plant cover) that they can be wisely used only for wildlife, recreation, watersheds, and esthetic appreciation.	70	1.0

3.2.2 Agricultural Climate

There are large differences in the climate in different zones within the Study area, mainly because of large differences in land elevation.

The climate in most parts of the Study area is semi-arid or arid. The average annual rainfall in the area varies depending on its elevation. In plains, the rainfall is small, ranging between 500 to 900mm. The annual rainfall is 930mm in San Juan, 660mm in Azua, 470mm in Neyba and 900mm in Barahona, which is increasing from north to south. The rainfall is very erratic with considerable variation year by year and most of annual rainfall concentrates in the rainy season. The annual evapotranspiration is estimated at about 2,200 mm, with maximum daily evapotranspiration of about 7.5 mm during the period from May to July. The average annual maximum and minimum temperatures are 28 °C and 24.5 °C, respectively. In the hilly and mountainous zones, rainfall varies from 800 mm to about 1,500 mm per year, and the annual mean temperature of the high mountains is as low as 18°C.

Such particular climatic characteristics in the Study area, especially low effective rainfall, cause the stagnation of agricultural development. Its climatic features in the are summarized in Figure 3.

3.2.3 Hydrology

(1) Rainfall and Seasons

Mean annual rainfall in the Study area ranges from about 500 mm in the Neiba Valley to over 1500 mm in the upper reach of the Yaque del Sur River. Mostly in the Project area, two peaks of monthly rainfall are observed, i.e., April to May and September to November. Probability (return period) of annual rainfall in the past is given in Table 2 for five stations in the Project area. Wet years in which the whole Project area received annual more rainfall than normal years were 1963, 1969, 1978, 1979, 1987, and 1992, while dry years were 1964, 1967, 1973, 1976, 1984 and 1991. Since the Project area has a vast watershed, the rainfall distribution varies by location to a large extent.

(2) River System

The Yaque del Sur River originates from the Central Mountain Ranges and flows into the Caribbean Sea at Barahona. The river has a catchment area of 4,972 km^2 with a total length of 156 km. The San Juan River is the largest tributary joining the Yaque del Sur River at Villarpando. The catchment areas at Villarpando are 1,709 km^2 (Yaque del Sur River) and 2,011 km^2 (San Juan River). Low flow probability analysis was made by a logarithmic normal distribution method using discharge data at major points in the Study area. The results are given in Table 3.

(3) Floods

It is reported that floods had occurred frequently before the construction of the Sabana Yegua Dam and Sabaneta Dam, and few serious floods occurred afterwards. However in September in 1998, Hurricane Georges brought a serious floods on the downstream reach of the basin in spite of efficient flood control by the dams. The flood discharge at the Santana headworks was estimated at about 10,000 m^3/sec which was the largest discharge after the construction of the dams.

(4) Sediment

According to the bathymetric survey results, total sediment volume in Sabaneta reservoir amounted to 10.9 MCM, which accounts for 16 % of the designed effective capacity (67.5 MCM). Annual sedimentation rate was 0.911 MCM/year which is equivalent to a specific sediment discharge of 2.0 mm/year/km^2. The specific sediment discharge was also estimated for Sabana Yegua Dam at 2.6 mm/year/km^2.

Few data or records are available on sediment load of river water in the Project area. However it was confirmed in the field that the San Juan River at Sabana Alta has a high sediment load. It is considered that the drained waters from Jose Juaquin Puello, San Juan and other irrigation systems contain a lot of suspended sediment even during low-flow periods. A similar phenomenon was confirmed at down reach of Santana Irrigation System, Arroyo Drain at Guara Guao.

(5) Hydro-geological Zone

The Study area is divided into four hydro-geological zones which were re-organized and defined by the "Plan Nacional de Investigacion Aprovechamiento y Control de Aguas Subterraneas (PLANIACAS)", 1983. They are i) San Juan Valley (No.8, Valle de San Juan), ii) Neiba Mountain Range (No.9, Sierra de Neiba), iii) Neiba Valley (No.10, Valle de Neiba), and iv) Azua Valley (No.13, Valle de Azua). Potential of groundwater is described in Sub-section 3.9.3.

(6) Water Quality

In the Dominican Republic, the **USDA classifications** of irrigation water salinity and sodicity are used for irrigation water evaluation. The classifications are given according to ranges of "sodium adsorption ratio" (SAR) and electric conductivity (EC) or equivalent salt concentration (TDS or Cl). As for drinking water, Normas Dominicanas No.436 **(NORDOM 436)** gives criteria on drinking water.

Field water sampling and laboratory tests were conducted during the study period. The water quality for the irrigation purpose was confirmed suitable for most of the water sources. Waters in Rincon Lagoon, drains in the Neiba Plain were evaluated inadequate for the Phase-1 study period (dry season of 1997/98). After passage of Hurricane Georges in 1998, the waters in the Rincon Lagoon and the drains were almost replaced with the flood waters, and the water quality water confirmed suitable for the irrigation. Most of the water sources were judged suitable for the drinking purpose with certain treatments.

3.3 Agriculture and Agricultural Production

3.3.1 Present Land Use

The present use of the land in the Study area is classified into 6 categories as follows. Land use map is illustrated on Figure 4.

Land Use	Area (ha)	Proportional %
1) Agricultural land	271,000	38.1
(1) Irrigated land	71,000	10.0
(2) Rainfed land (excluding shifting cultivation)	46,000	6.5
(3) Shifting cultivation and natural pasture land	154,000	21.6
2) Forest and bush land	394,000	55.4
(1) Dry land forest	175,000	24.6
(2) Humidland forest	84,000	11.8
(3) Bush and shrub	135,000	19.0
3) Wet land	3,000	0.4
4) Barren land	37,000	5.2
5) Water bodies	4,000	0.6
6) Urban/village area/others	2,000	0.3
Total	711,000	100.0

Source: land use and cover map, SEA, based on 1992 landsat

Especially, in the shifting cultivation, farmers cut trees in the national forests or shrub lands and illegally cultivate some crops on it at an interval of 3 to 5 years. The lands with the shifting cultivation are the poorest in vegetation, in which casuses severe soil erosion and deterioration of soils themselves. As mentioned in section 3.2.3(4), soils are eroded out with a rate of 2-2.6 mm/year/ km^2 in the upstream area of Sabaneta and Sabana Yegua dam. Such sedimentation problem has decrease the effective storage capacity of dams. In the irrigated field, sedimentation in the irrigation canal makes trouble and also soil erosion depressed agricultural land productivity in the upstream basin of the Yaque del sur river.

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

3.3.2 Cropping Pattern and Farming Practice

(1) Cropping Pattern

In the Study area, many kinds of crops are cultivated. Since the Study area is so large, agricultural climatic condition, irrigation condition and presence of agro-processing factories in the Study area vary largely depending on location. The main crops in the Study area are summarized below:

Irrigation District Area	Main crops cultivated under irrigated condition	Main crops cultivated under rainfed
Azua irrigation district	Plantain, banana, rice, tomato, cassava, corn, sorghum	red bean, pigeon pea, coffee
San Juan irrigation district	red bean, rice, sweet potato, corn	red bean, corn, pigeon pea, coffee
Yaque del Sur irrigation district	Plantain, banana, sugar cane, cassava	
Lago-Enriquillo irrigation district	Plantain, banana, sugar cane	pigeon pea, coffee

Crops such as plantain, banana, tomato, rice, sugar cane, red beans and cassava are mainly cultivated under irrigated lands. Pigeon pea, part of red beans and coffee are cultivated under rainfed conditions. Cultivation areas for each crop are estimated based on the data in the recent 5 years as below:

(unit : ha)

Crop	Irrigation area	Rainfed area
plantain	10,560	40
banana	2,390	65
Red bean	10,100	3,510
rice	8,400	-
sugarcane	8,200	-
tomato	3,320	-
Sweet potato	2,300	450
cassava	1,560	440
corn	2,180	1,060
sorghum	1,690	-
pigeon pea	690	8,440
coffee	-	12,100

Plantain, banana and sugar cane are grown all year round. Tomato is produced for tomato paste production, which is normally from the end of October up to the middle of March. Because of the large presence of the insect named "White fly" (Bemisia tabaci) which transmits a virus disease deadly to tomato plants, SEA has defined a fixed period during the year when tomato can be grown in Azua and other nearby areas. Rice is cultivated in both seasons, (i) the period from the beginning of May to the middle of September and (ii) the period from the beginning of November to the middle of March. Most of sweet potato and sorghum are planted from the beginning of May to harvest from the beginning of September. Red beans are planted starting at the end of October and harvested at the beginning of February due to a mild climate condition. Cropping intensity in the irrigated lands varies at the ranges between 60% to 120% depending on the irrigation system. Because of the shortage of the irrigation water, lack or deterioration of irrigation facilities and poor water management system, loss of the irrigation water is so high and causes the low irrigation efficiency. The average cropping intensity is 80%. In addition, lack of fund for purchasing fertilizer, seeds and agricultural chemicals and lack of tractor for land preparation are also one of the reason for such a low cropping intensity. Cropping pattern is illustrated on Figure 5.

Most of red beans and pigeon peas are cultivated in the rainfed lands and shifting culture lands of which interval ranges between 3 and 5 years. The cultivated lands for them fully depend on the rainfall and largely fluctuates year by year. They are planted on the beginning of the rainy season, generally August, and harvested at the middle of December for red beans and March for pigeon peas. Cropping intensity is less than one. In addition to them, coffee is grown all year round under rainfed conditions.

(2) Farming Practices

Present farming practices and their problems of the main crops under irrigated lands in the Study area are shown in Table 4 that indicates methods of land preparation, varieties of crops planting method, fertilization, irrigation, pest control, disease control, weed control and harvesting. The technical problems are summarized below;

i) Land preparation is not done timely and properly due to lack of mechanical power.

ii) Most of farmers use poor quality of seeds and seedlings.

iii) A level of application of farm inputs such as fertilizer and chemicals is low.

iv) Farm inputs is not always applied at right time and right volume and

v) Management of no-farm water is poorly done and irrigation water is short.

The background of the above problems are accrued from (1) farmers don't intend to apply the farm inputs sufficiently on their farm plots because they consider that they might not get irrigation water satisfactorily due to deterioration of existing irrigation facilities, inadequate water management and so on, (2) Access to the credits is very difficult due to no mortgage for loans, complicated procedure system of loan request, small available amount of loans of agriculture bank, high interest, and so forth. (3) farmer's low level of technology and farming practices (4) extension and support services to farmers are not sufficient.

In the rainfed agricultural lands, all farming activities for coffee, pigeon peas and red-bean are done by family labor. Problems of farm practices in the rainfed area are summarized below;

i) Most of farmers use poor seeds and seedlings.

ii) Especially, farmers widely use varieties of pigeon pea with a long growth period of 9 months in the Study area. Though it has a good characteristics of high resistance against the diseases and insects, its yield is obliged to become low because of low use of effective rainfall.

iii) Most of farmers use less or none fertilizer and pesticides

iv) Present farm practice has no any care to soil deterioration and sustaining fertile soil

The background of the above problems are accrued from (1) farm practices in the raifed area to which the farmers apply are so poor that the farmers do not carry out the contour cultivation, a basic farming method for soil conservation, (2) the rainfed lands are usually located away from the extension service center, so that farmers can get few services from the center, (3) farmers in the rainfed area are so poor that farmers have no fund for purchasing farm inputs and accrss to loans of the agricultural bank is more difficult than that of the irrigated farmers. Under such circumstance, it is necessary to abolish the sifting cultivation and to promote sedentary cultivation. It is essential to expand the sustainable agricultural with low farm inputs in the rainfed area, being paid on soil conservation and improvement of soil fertility.

As for the coffee production , 60% of the total cultivated area (12,000ha) is covered by the trees with Typica variety which are beyond the economic durability period (30 years). In addition, because of the poor farmer's farming practice, the yield of coffee is so low. And also its quality is extremely low, because of poor facilities of agro-processing, shortage of the number of facilities and lack of drying yard. Since there is no agricultural cooperatives of coffee farmers, the farmers have no bargaining power in the market against the local middleman. The farm gate price is so low and farmer's incomes are also low. The problems of coffee farmers are as same as that shown in rainfed farmers who cultivate red-beams and pigeon pea farmers.

3.3.3 Crop Yield and Crop Production

(1) Crop Yield

Yields of crops in the Study area both under irrigated and rainfed conditions are estimated as follows:

(unit:ton/ha)

Main Crop	Azua Irrigation District Area		San Juan Irrigation District Area		Yaque del Sur Irrigation District Area		Lago Enriquillo Irrigation District Area		National Level	
	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated
Plantain	13	18	12	17		18		18	14	19
Banana	13	26	14	24	12	26	12	26	18	28
Red bean	0.3	0.9	0.4	1.1	0.25	0.9	0.25	0.9	0.5	0.9
Rice		2.5		3.0		2.2		2.2		3.2
Sugar cane						30		30	28	30
Tomato		25		23		24		24		21
Sweet potato	7	12	8	13	7	12	7	12	9.5	14
Cassava		9	5	10	5	8	5	8	7	9
Corn		2	0.9	2.0	0.8	1.8	0.8	1.8	1	2.2
Sorghum		3.5		3.5		3.3		3.3	2.2	4
Pigeon pea	0.95	1.7	0.95	1.9	0.87	1.3	0.87	1.3	1.1	1.6
Coffee	0.25		0.25				0.25		0.3	
Cocoa	0.3		0.3				0.25		0.3	
Papaya		48		52				48		60
Pepper		15		16				14		14
Melon		35		34				35		35
Eggplant		16		17				15		15

As shown in the above table, yields of crops in the Study area are low in general. Compared with crop yields at national level, those in the Study area are low in both under irrigated and rainfed conditions.

(2) Crop Production

The total production of major crops in the Study area is estimated in the following table.

(unit: ton)

Main Crop	Azua Irrigation District Area	San Juan Irrigation District Area	Yaque del Sur Irrigation District Area	Lago Enriquillo Irrigation District Area	Total In the Study Area
Plantain	81,400	4,400	113,100	14,000	212,900
Banana	23,300	5,000	41,100	800	70,200
Red bean	1,300	10,900	70	200	12,470
Rice	970	23,900	100	100	25,070
Sugar cane			34,200	230,000	264,200
Tomato	79,200		1,500	2,300	83,000
Sweet potato	3,500	27,600	1,400	700	33,200
Cassava	4,700	5,100	2,300	4,100	16,200
Corn	1,900	2,700	100	600	5,300
Sorghum	3,000	2,600	150	200	5,900
Pigeon pea	1,800	6,100	20	1,000	8,900
Coffee	1,600	375		1,000	3,000
Cocoa	120	60		100	280
Papaya	7,200	10,900			18,100
Pepper	1,200	2,100			3,300
Melon	1,200	2,600			3,800
Eggplant	1,100	2,400		150	3,600

3.3.4 Livestock Production

Livestock production within the Study area is small. The large majority of farmers engaged in livestock production are doing this as a secondary economic activity. The

cattle population is approximately 30,000 units, the pig population is 18,000 units, and there are relatively important production of goats and sheep but their population is not known.

3.4 Marketing and Prices

3.4.1 Marketing System of Main Agricultural Crop Production

In the Study area, main staple food crops such as plantain, sweet potato, red beans, most of pigeon peas and rice are self-consumed locally or in Santo Domingo city. Most of coffee and remained plantain (3% of the total product) are exported. Part of organic farming banana and vegetables in winter season such as melon and Chinese cabbage is exported on a small scale.

Staple food crops in the Study area are mainly marked from producers through local middlemen and processing firms to local markets and finally to consumers. In terms of agricultural cooperatives, only a few cooperatives, such as San Juan agricultural cooperative in San Juan provice and COOFEPROCA in Azua province and so on, conduct cooperative collection of crop products and marketing. Pigeon peas, red beans and rice that are consumed in Santo Domingo city are marketed from producers through wholesaler and retailer to consumers. General marketing flows of staple food crops are shown in Figure 6. Plantain and banana that remain after consumption in the Study area and Santo Domingo are exported directly through local middlemen. Coffee is marketed from producer to processing firms who export it. About 95% of the tomatos are processed. Tomato producers make contracts with processing firms and SEA and in terms of price, the area to be planted and buying conditions and sale products to tomato processing firms that finally sell the production to domestic markets. Main constraints in the market system of agricultural products are high margins that the truckers, local middle men and processing firms receive.

3.4.2 Marketing of Farm Inputs

The Center for Input Sales (CEVEMA) distributes agrochemical inputs and fertilizers at subsidized prices. Fertilizers are being produced locally by two main companies. Import of fertilizers is very low and it is used mainly on gardens. Those two companies also are major importers of other chemical inputs such as insecticides, fungicides and herbicides.

SEA provides machine services through the Center for Machine Services (CESMA). The service rate of government-owned tractors is much lower than the private ones and in some cases is free. However, the coverage of the government machinery service is small due to low availability of tractors and equipment. Thus, farmers use private service to assure land preparation on time. In the Study area there are three Centers of Machines Services in Azua, Barahona and San Juan.

3.4.3 Trade Condition

Within the Study area, plantain, banana, coffee and most of quantity winter vegetables such as melons and Chinese vegetables are exported most of which are shipped

through Haina Port. The main market for national exports is the United States, which absorbs nearly 50% of the total country's exports. The other main markets are Holland, Puerto Rico, Korea and Japan. Some productions have preferential market access to the European Union due to the Lome IV Convention. By virtue of that agreement, export of agricultural produce, especially bananas, could enter the European market free of duty. There are some problems with the size of the operation for a farmer to export to the USA that convey the necessity of farmer's consortium for export.

3.4.4 Marketing Information System

There is no marketing information system in the Study area. JAD has tried to perform a small-scaled pilot scheme of marketing information system. Price information at the different level in the marketing channel is collected by extension agents and sent to Santo Domingo on an irregular basis. In Santo Domingo the data collected is used for statistical purposes. Some television programs with national coverage provide daily information on wholesale and retail prices at the Santo Domingo market.

Dominican Agribusiness Council (JAD; Junta Agroempresarreal Dominicana) are carrying out a few small-scale pilot projects on agricultural market information system experimentally. Under JAD at Santo Domingo, there are several branches in the agricultural production areas. The branches collect agricultural data and send them to JAD. It processes such data and send back them to the branches. It also send information on domestic market, international market and technical matters. It is the agricultural information exchange system among the producer, the supplier and the consumer. In the Study area, there are 2 branch offices of JAD. One is in the San Juan Agricultural Cooperative that mainly comprises rice and red-bean farmers, and the other is in COOFEPROCA which consists of the tomato and plantain farmers in Azua. The 2-JAD officer assigned in the branch offices collects information of the farm gate prices, cultivated areas, harvest areas, information of disease and insects, climate and so on from farmers, cooperatives and federation of agricultural cooperatives daily. The branch offices send the information JAD headquarters in Santo Domingo by computer every day and JAD headquarters compiles it. In compliance with the request from the cooperatives and the federation, JAD provides information such as the price in the other area, market price of plantain, banana, rice, red-bean in Santo Doming, the international market prices of plantain and rice, and so on to by means of e-mail, fax and document. After receiving the information, the cooperatives publish it by paper or oral to the farmer. Recently the cooperatives deal with information from JAD as one of market information source. Hereafter this information system can be strengthened by increasing the information from production side and consumer side(such as participation of supermarket, consumer association, shop of farming consumable, NGOs and so on).

3.4.5 Regulations Related to Marketing

The government has promoted the elimination of all tariff and barrier to domestic agricultural production and trade. The Price Stabilization Institute (INESPRE) that functioned supporting price for crops was practically closed down. At present, however, the Government still intervenes in a handful of crops such as rice, red beans, poultry and garlic. There are some government interventions in the marketing of agricultural products

in the region, price setting of some agricultural commodities, stabilization, import of some food items, import licenses and so forth.

3.4.6 Market Place Condition

Market infrastructure is not adequate, and in most cases very old. The conditions for the display and storage of products are not good. Most of the time agricultural produces are displayed on the ground and there is not much concern for their quality and preservation. The degree of value added is minimal and there exists an array of measures and weights which make it difficult to standardize the system.

In most villages, the local and regional merchants use market structures only once a week. There is no supervision by the local authorities or any public institution on safety standards and consumer satisfaction.

3.4.7 Prices of Agricultural Products

Farm gate prices for the main crops in the Study area show heavy fluctuation throughout the year and achieved it lowest point at the harvest. The marketing margin between producer and consumer price ranges from 35 to 70% of the final price. In most cases, prices are determined by the market under the heavy influence of local middlemen. In the case of industrial tomato there is a predetermined price established in production contract by the agro-industries. The marketing margin for the main crops is shown in Figs.3.4.4 to 3.4.8 in annex-I.

3.4.8 Agro-processing Facilities

The main agro-processing facilities are rice mills, coffee processing (drying and peeling and bagging) and tomato paste processing. In the case of coffee the degree of processing and the capacity is minimal. Other processing facilities include small cassava processing (cassava bread), and small milk processing.

3.5 Irrigation and Drainage

3.5.1 Features of the Existing Irrigation and Drainage Systems

The Study area covers the entire basin of the Yaque del Sur River and areas served or expected to be served by the water resources of the Yaque del Sur River. The river system has two storage dams; Sabana Yegua Dam with a 386 MCM capacity on the Yaque del Sur River and the Sabaneta Dam with a 78 MCM capacity on the San Juan River, which is the biggest tributary of the Yaque del Sur River. The irrigation area is estimated at 70,000 ha in total, of which about 85 % are served by the Yaque del Sur River system, and the remaining irrigation areas are served by small streams or groundwater. Irrigation area is geographically divided into three areas such as San Juan irrigation area, Azua irrigation area, and Yaque del Sur – Lago Enriquillo irrigation area. General layout of the present main irrigation systems in the Study area is illustrated on Figure7.

(1) San Juan irrigation area

The San Juan irrigation area is located in the upstream part of the Yaque del Sur

River. There are several major and minor irrigation systems diverting water from the San Juan River or the tributaries. The irrigation area is estimated at 24,300 ha in total including an irrigation area of 3,800 ha situated outside the Study area, of which 20,070 ha are directly served by the San Juan River and Sabaneta Dam and remaining 4,230 ha are served by the tributaries of the San Juan River. Major irrigation systems are listed in the following table:

Major Irrigation System in San Juan Irrigation District in the Study Area

Name of Canal System	Water Source	Irrigation Area (ha)
Jose Joaquin Puello	San Juan River	10,986
Las Matas de Farfan (outside the Study Area)		(3,798)
San Juan	San Juan River	5,526
Hato del Padre	San Juan River	2,059
Guanito San Juan	San Juan River	1,000
Mijo	Mijo River	2,390
Los Baos	Los Baos River	495

Sabaneta Dam, which was completed in 1978 is located in the upstream reaches of the San Juan River, about 16 km north of San Juan city. From 1997 to 1998 the upstream slope of the dam was reinforced with rock riprap and an emergency spillway was constructed in the left shoulder.

Primary features of Sabaneta Dam are as follows:

Purposes of dam: Irrigation and domestic water supply and hydropower generation
Catchment area: 464 km^2
Gross storage: 78 MCM
Effective storage: 67.5 MCM
Dam type: Center core type rockfill
Dam height: 70 m max.
Hydropower plant (Max. power): 6,853 kW

The dam was damaged with erosion in the downstream of the emergency spillway by excess water spilled out through the spillway at Hurricane George.

Three irrigation systems on the above table, the Jose Joaquin Puello, the San Juan, and the Hato de Padre, were originally completed in 1978 with Sabaneta Dam. In 1992 to 1994, the San Juan Irrigation system was improved with a new main canal construction in order to extend the irrigation area. In the recent years the three irrigation systems have been rehabilitated and improved in their canal systems and water users' organization to carry out the water management by farmers themselves is being founded and reinforced under the technical and financial support of PRODAS. They are relatively functioning well from the head to the field level.

Guanito San Juan System is located at the most downstream among the irrigation systems benefited by the San Juan River. Since then, the system is endowed with return flow from the Jose Joaquin Puello and the Hato de Padre irrigation systems. In early 1990s, the headworks and main canal were rehabilitated, but the last reaches of about 5 km is still left as an earth canal. A water user's association has not been organized yet.

Mijo irrigation system is one of the oldest irrigation systems in San Juan basin.

PROMASIR has a concrete plan to assist farmers to organize their water users organization with improvement of the existing irrigation and drainage systems.

(2) Sabana Yegua Dam

Sabana Yegua Dam is located in the middle reaches of the Yaque del Sur River, a point of about 3 km from a confluence of the Yaque del Sur with the San Juan River or the joining of three rivers, the Yaque del Sur, the Grande, and Las Cuavas. It was completed in 1978 for efficient use of water resources for domestic and irrigation in Azua and Yaque del Sur downstream areas. Also the dam contributes to the hydro-power generation by using water released through a generator and flood mitigation in the downstream area by providing the flood control capacity in the reservoir.

Primary features of Sabana Yegua Dam are as follows:

Purposes of dam:	Domestic and irrigation water supply with power generation
Gross storage:	433 MCM (design)
Effective storage:	386 MCM (design)
Dam type:	Center core rock-fill type
Dam height:	96 m
Hydropower plant (Max. power):	13,000 kW

(3) Irrigation Area in Azua Irrigation District

Irrigation Area in Azua Irrigation District is largely divided into four areas. One is an irrigation area of 2,625 ha in Padres Las Casas Irrigation Sub-zone, which is located in the upstream of Sabana Yegua Dam. Second is an irrigation area of 3,466 ha consisting of 2,366 ha directly served by the Yaque del Sur River and 1,100 ha directly taking water from YSURA head race. Third is an irrigation area of 10,007 ha located in the outside of the Yaque del Sur River Basin, but served with water diverted from the Yaque del Sur River through YSURA canal system. Fourth is an area of 1,784 ha irrigated by tubewells mainly in the eastern part of Azua plain. The total irrigation area is 19,064 ha and the area served by the Yaque del Sur is estimated at 13,473 ha except Padres Las Casas zone.

The YSURA canal area is further divided into an area of 7,732 hectares made up of modernized YSURA canal system and an extension area of 2,275, where the most of canals including the YSURA canal remain without improvement. In the YSURA southern area, the area of about 600 ha where the altitude is less than 40 m is suffering from salinity problems due to improper irrigation practices and insufficient drainage facilities

The YSURA canal system was built in 1978 together with Sabana Yegua Dam. Water is diverted at Villarpando, conveyed through a headrace to the Tabara River and diverted again by a diversion weir and conveyed through main canals and laterals and distributed through field canals to fields. The canal system is working relatively well, although deteriorated facilties especially steel gates including the intake and sand-flushing gates of Villarpando headworks can be seen.

The irrigation area of 2,366 ha directly served by the Yaque del Sur River is located along the Yaque del Sur River in the reaches from the Sabana Yegua Dam to Los Guiros,

which belong to Azua Irrigation District. There exist ten (10) small irrigation systems. All the intakes are of free intake type and all the irrigation systems are earthen-made with only a few structures. In the area of 1,100 ha directly taking water from YSURA headrace, water is taken by privately installed flexible pipes at many points.

(4) Yaque de Sur - Lago Enriquillo Irrigation District

In 1996, Yaque del Sur Irrigation District is divided into two districts namely, as Lago Enriquillo Irrigation District and Yaque del Sur Irrigation District. Right bank irrigation areas of the Yaque del Sur River up to the irrigation area of Santana irrigation system as well as the other irrigation systems located along the northern hills of Neyba are managed by the Lago Enriquillo. Left bank irrigation areas and irrigation areas located along south edge of Neyba plain belong to the Yaque del Sur.

Existing irrigation area is estimated at about 26,500 ha in the Study area, of which 84% or 22,200 ha is served by the Yaque del Sur River. The remaining areas are located south edge (Cabral section area) or north edge (Galvan) of Neyba plain served by small rivers, springs, or groundwater. Of the 22,200 ha served by the Yaque del Sur, sugarcane fields managed by Sugar Company C.E.A occupies about 13,400 ha or 60 %.

Irrigation areas served by the Yaque del Sur River are divided into three zones from the characteristics of irrigation systems such as an area covered by (i) a group of small irrigation systems located along the valley of the Yaque del Sur River in the upstream reaches of Santana intake, (ii) Santana irrigation system, which is the biggest irrigation system in the downstream reaches of the Yaque del Sur, and (iii) an area covered by small irrigation systems located along the downstream reaches of the Yaque del Sur from the Santana intake point.

In the area (i) on the above, there are at least 11 irrigation systems. Most of the diversion works are of free intake type and all the irrigation systems are of earthen-made type with only a few structures. Total benefited area is estimated at 2,791 ha. San Ramon canal is being extended at present and expected to serve from the present 366 ha to 1,116 ha.

Santana Irrigation System was built in 1916. It has been managed mainly by Sugar Company C.E.A. serving mainly sugarcane plantation in the right bank area of the Yaque del Sur River, about 12,000 ha. Santana headworks has been damaged in most of the intake and sand flushing gates and deteriorated in some parts of the concrete piers. The canal system is not maintained well and related structures are much deteriorated. Under such physical conditions, water management cannot be made properly and much amount of water seems to be wasted as seen in the vast amount of water flowing down the drainage canals.

The area (iii) on the above is the most downstream in the Yaque del Sur River and the irrigation systems have a pumping station at the head except a few gravity systems. The irrigation area is about 7,000 ha in total including sugarcane plantation managed by CEA.

3.5.2 Organization for Operation and Maintenance and Water Management

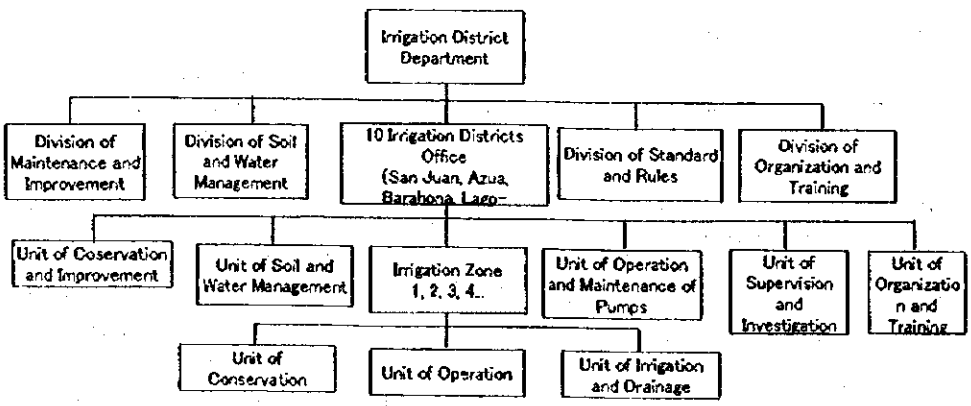
The INDRHI is the institution in charge of all the water resources of the country and carries out river system water management including irrigation systems. In recent years since 1990, INDRHI has guided farmers to organize WUO through PRODAS, PROMASIR, and other projects in order to manage irrigation water and carry out operation and maintenance of irrigation facilities instead of INDRHI in each of irrigation systems well developed up to tertiary canal systems. But in many irrigation systems, INDRHI has still directly executed the water management.

(1) Organization of INDRHI for Operation and Maintenance

Operation and Maintenance (O&M) of irrigation and drainage facilities are under the control of the Irrigation District Department of INDRHI.

INDRHI is managing 309 irrigation systems with a total irrigation area of 261,000 ha in the nation. There are 10 Irrigation Districts under the Irrigation District Department. Further each Irrigation District is divided into a few zones. The Study Area is covered by four Irrigation Districts such as San Juan Irrigation District, Azua Irrigation District, Yaque del Sur Irrigation District, and Lago Enriquillo Irrigation District.

The Irrigation District office has five units such as Conservation and Improvement, Water and Soil Management, Pumps Operation and Maintenance, Supervision and Investigation, and Organization and Qualification. The irrigation Zone office has a conservation unit, operation unit, and irrigation and drainage investigation unit. The staff actually carry out operation and maintenance works in the fields under the supervision of the District Office.



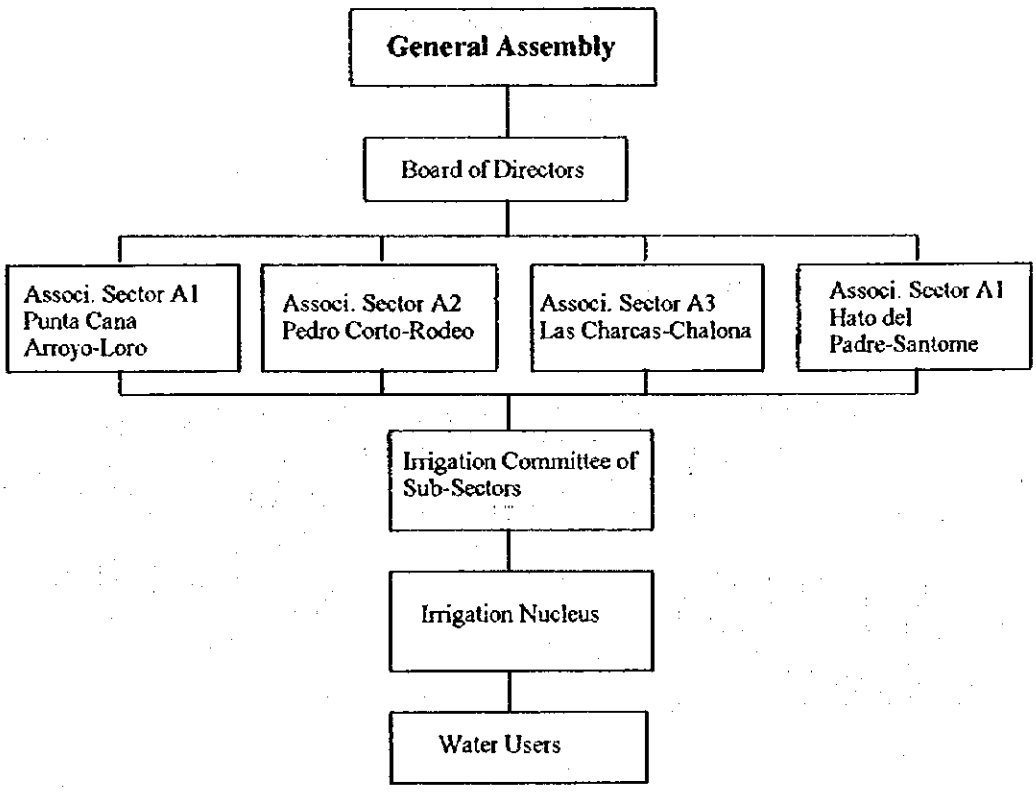
(2) Water User's Organization

INDRHI have put high priority on the formulation of water user's organization (WUO) for all irrigation systems and are strengthening existing organizations in order to execute operation and maintenance of irrigation and drainage systems by farmers themselves in line with the policy of the beneficiaries participatory approach.

There are several WUOs in the Study area. In San Juan valley irrigation zone, a WUO, the so-called Sabaneta Dam Irrigation Committee, has been organized in the irrigation systems of the right bank side of the San Juan River such as Jose Joaquin Puello irrigation system and Hato de Padre irrigation system and being introduced in San Juan irrigation system together with tertiary canal system development under the guidance of PRODAS. Mijo irrigation system will be taken up as a first objective system for organizing water user's association under PROMASIR. In the Azua irrigation zone, a WUO, the so-called the YSURA Irrigation Committee was founded in the 1980s in YSURA canal system area. This is the first organization of its kind in Dominican Republic. At the same time, 2 WUOs (Peñon and Fundación) were founded in some of the small irrigation systems in the Yaque del Sur Irrigation District as well. However these pump irrigation systems could not deliver irrigation water properly because of the deterioration of facilities and unstable supply of water due to the frequent power cut. Since these facilities were not rehabilitated, INDRHI did not turn over them to WUOs when WUOs were established. Such situations have been continued by now. The operation and maintenance of the irrigation facilities is still under the management of INDRHI. Thus these WUOs do not function at present. Of these WUOs, the Sabaneta Dam Irrigation Committee is functioning most.

The organization of the Sabaneta Dam Irrigation Committee is shown in the following figure.

Organization of Sabaneta Dam Irrigation Committee



The General Assembly, as a maximum authority, will meet twice (2) a year and at

necessary times. The Board of Directors is made up of one president, one vice president, a treasurer, two secretaries (one for documentation and the other for organization) and other few members. They are chosen by the General Assembly and will remain for two years in their position. The Irrigation Committee is employing a force of management staff, which actually executes the plans and programs under the Board of Directors. They make operation plans and schedules and actually operate the headworks and main and major laterals.

As for the YSURA Canal Irrigation Committee, the hierarchy is almost the same as the Sabaneta Dam Irrigation Committee. The Board makes a schedule of water distribution from the YSURA main canal to the laterals. A force of management staff has been organized under the Board of Directors in order to actually execute the plans and programs under one manager.

The Sabaneta Dam Irrigation Committee and YSURA Canal Irrigation Committee have not been technically and financially independent from INDRHI. Collected amount of water charge is very small due to a low collection rate and low charge of water fee and thus far behind the amount required for the operation and maintenance of facilities. Much of the annual budget is coming from INDRHI. There is an extreme lack of qualified staffs who can make timely water management on volume basis including estimate of irrigation water requirements and preparation of irrigation water distribution schedule. Poor management is causing a constant dispute among beneficiaries.

(3) Water charges

The collection rate of water charge is 10 % to 12 % only in the traditional irrigation systems where no WUO is founded. While, in the area operated by the Sabaneta Dam Committee the collection rate was 52 % in 1996 and reaches about 80 % in fiscal year 1997/98. In the YSURA Irrigation Committee, the collection rate of water charge gradually improved to 68 % in 1997. Unit rate of the water charge was DR$ 191/ha in 1997 in the area less than 1 ha of upland crops in the Sabaneta and DR$ 287/ha in the YSURA.

3.5.3 Present Water Distribution and Maintenance

(1) Basin Water Distribution

In order to coordinate and program the distribution of surface water resources of the Yaque del Sur River, a committee has been organized with 10 members; five (5), each from INDRHI head office and San Juan, Azua, Yeque del Sur, and Lago Enriquillo Irrigation District offices and four (4) of farmers' representatives and one from a sugarcane company.

This committee is responsible for the basin water management as well as review, establishment and/or formulation of the policies and standard for the operation of the irrigation systems. This committee holds meetings twice a year in a normal year or bimonthly in a drought year.

Based on the water distribution program decided in the above committee, a joint committee of INDRHI and CDE is held to place the irrigation program to decide water-

release program from the dams. The joint committee meeting is usually held twice a month. Then, CDE informs the water-release schedule to the site offices of Sabaneta and Sabana Yegua Dams in accordance with the decision. Based on the water-release schedule, the site offices of Sabaneta and Sabana Yegua Dams regulate the outlets of the dams to control the released amount of water.

The Azua Irrigation District office operates the Villarpando intake. In this operation, the river discharge and water demands in the downstream of the Yaque del Sur River is not directly taken into account.

The Villarpando headworks is a kind of a diversion structure and so has to fairly divert water between Azua area and Yaque del Sur - Lago Enriquillo area. However from the structural point of view, it is very difficult to fairly divert water due to different type of diversion structures: one is of orifice type and the other is of overflow type. Water to the Azua area is diverted through sluice gates and water to Yaque del Sur - Lago Enriquillo area flows over the fixed weir. The former type is insensitive against the variation of water level and the latter is sensitive against that. It means that the flow to the Azua area is more stable than that to the Yaque del Sur - Lago Enriquillo area. Also, the very lengthy crest of the overflow weir with shallow overflow depth brings about difficulty of the flow measurement. From this point of view, the Yaque del Sur - Lago Enriquillo area is handicapped.

(2) Irrigation System Operation

As for the San Juan irrigation area, based on the water released program of Sabaneta Dam, which is determined by the joint committee, San Juan Irrigation District office will make a water allocation schedule among J.J.Puello, San Juan and Hato de Padre irrigation systems in collaboration with the Sabaneta Dam Irrigation Committee. The Guanito San Juan system is not taken into account in the released amount of the Sabaneta Dam, because the system is mostly maintained on the return flows from the J.J.Puello and the Hato de Padre. During the wet season generally all three systems continuously takes water from the San Juan River. In the dry season, when reservoir storage decreases, rotation of water diversion is made among the three systems. The respective irrigation systems are managed on rotational basis as well. The rotation is made among laterals or in the laterals or in both.

While the area is directly managed by INDRHI, INDRHI staff manages all the control and regulating structures from the headworks to the offtakes to tertiary canals. Then after farmers themselves do the water management works.

In the reaches of the YSURA headrace, farmers are diverting water freely from the headrace by pipes installed by themselves all year round even in no water-using period without any payment of water charge. The amount of water taken on the way is estimated at 15% to 25 % of the diversion discharge. In the YSURA area, when water is small in the dry season and short against the irrigation demands, rotational supply is made between laterals.

Small irrigation systems existing along the Yaque del Sur River in the reaches from the Villarpando to the Santana intake take water mostly through free intakes throughout

the year without any regulation and the irrigation areas are generally endowed with sufficient amount of water.

Meanwhile, in the irrigation areas served by the Santana and Vicente Noble headworks and by pumping stations located along the lower reaches of the Yaque del Sur River, farmers and a person in charge of water distribution are suffering in the irrigation water supply during drought periods. In drought periods, the Santana intake and the other intakes including pumping stations located along the Yaque del Sur River in the downstream of the Santana, alternatively take water during the week, 4 days for the Santana intake (CEA) and 3 days for other systems.

The Santana canal systems are operated by CEA. About 130 persons are engaged in the irrigation practices including water distribution works, but the irrigation facilities including control and regulation structures cannot be properly operated due to the severe deterioration. The Vicente Noble system diverts water by gated intake with no weir in which the flow totally depends on the river discharge.

The pump irrigation systems suffer from the irregular interruption of electric supply. The daily operation hour is limited to five to eight hours.

(3) On-Farm Level Operation

In the area managed by WUO, a chief of nucleus is to make a irrigation rotation schedule among the members' farms. The chief, the assistant and the concerned farmer are to distribute water in accordance with the schedule. According to the interview survey among farmers, however, farmers sometimes encounter the difficulty of obtaining irrigation water due to disorderly diversion of water in the upstream reaches.

In the area directly managed by INDRHI, farmers are informed of the date of water delivery to their fields from the water distribution technician of INDRHI. According to this information, farmers are working for water distribution in their fields. The water distribution works are sometimes disturbed among farmers in the dry season.

In the sugarcane fields managed by CEA, employees of CEA manage water distribution. Sugarcane is irrigated by the furrow irrigation method at 15 days to one month intervals. Irrigation is practiced during the daytime only and irrigation water is wasted during night time without utilization and/or with water-logging. The irrigation application efficiency seems to be very low.

(4) Maintenance and Repairing of Irrigation and Drainage Facilities

Major canals and the related structures have to be maintained by the Irrigation District Office or by an WUO, if an WUO exists. There is, however, actually very little maintainance. Many of the steel gates are left with no lubricant and get rusty with little maintenance. Only one or two times a year, the Irrigation District office carries out minor maintenance works such as canal cleaning, removing sediments and debris in major canals by manpower employed tentatively.

As for the area managed by WUO, minor routine works are carried out somewhat. It

is difficult for WUO to carry out major maintenance works, since the budget, equipment and staff are limited. When repair is needed, WUO asks the Irrigation District Office, who has equipment. Such a situation is expected to gradually improve with the increase of revenue from water charges and continuation of INDRHI technical assistance.

In the Santana irrigation and drainage system, it seems that CEA almost gives up the maintenance of facilities because of little budget. Only some of the almost ruined gates are maintained with lubricants.

3.5.4 Present Irrigation Water Requirements

The present irrigation water requirements were estimated under the present cropping patterns as shown in the following table on the assumption that the irrigation efficiency is in the range from 0.31 to 0.40 for upland crops and from 0.39 to 0.49 for paddy.

Summary of Irrigation Water Requirements in the Area served by the Yaque del Sur River estimated based on Present Cropping Patterns (Unit : MCM)

Irrigation Zone & System	Nov.	Dec.	Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
San Juan Irrigation District													
J.J.Puello	5.3	13.5	14.5	9.4	2.7	2.2	9.4	16.4	12.1	10.1	6.8	4.0	106.4
San Juan	4.1	9.5	10.4	7.3	2.6	1.4	10.9	19.7	15.6	13.0	9.5	5.3	109.4
Hato de Padre	1.0	2.9	3.5	2.4	1.0	0.7	3.6	6.1	4.7	4.1	3.0	1.7	34.7
Ganito S. Juan	0.5	1.3	1.5	0.9	2.1	3.2	4.5	4.6	4.3	3.2	1.5	0.6	28.3
Other small system*1.4	3.6	4.2	2.8	0.9	0.6	5.4	9.3	7.3	6.2	4.6	2.6	48.7	
Mijo	3.5	4.4	5.9	4.2	1.8	1.3	5.3	9.2	11.2	7.9	5.8	4.3	64.8
Vallejuelo	0.7	0.9	0.4	0.1	0.1	0.2	0.2	0.4	0.4	0.2	0.1	0.1	3.6
Total	16.4	36.0	40.2	27.2	11.3	9.6	39.3	65.7	55.5	44.7	31.4	18.5	396.0
Azua Irrigation District													
YSURA H.R	1.4	2.0	2.5	2.5	2.3	1.7	1.3	1.8	2.6	2.0	1.3	0.8	22.2
YSURA	16.0	23.7	24.9	23.6	21.3	21.8	17.8	21.8	23.7	16.6	10.8	6.9	228.8
Total	17.4	25.7	27.3	26.0	23.6	23.5	19.1	23.5	26.3	18.6	12.2	7.7	251.0
Yaque del Sur - Lago Enriquillo Zone													
Area A1	3.1	4.4	5.3	5.3	5.0	3.6	2.8	3.8	5.6	4.3	2.9	1.8	47.9
Area B1	7.6	8.4	9.5	9.5	11.5	10.7	8.9	9.7	13.2	10.6	8.6	7.2	115.5
Area B2	36.5	37.6	39.3	36.0	41.3	37.1	29.7	34.1	49.3	44.0	40.5	36.8	462.1
Area B3	7.5	8.3	9.4	9.4	11.3	10.5	8.7	9.4	12.8	10.3	8.4	7.1	113.1
Area B4	0.9	1.0	1.2	1.2	1.4	1.3	1.1	1.2	1.6	1.3	1.1	0.9	14.3
Area B5	3.7	3.9	4.3	4.1	4.8	4.4	3.6	4.0	5.6	4.7	4.1	3.6	50.7
Area B6	6.8	7.3	8.1	7.9	9.4	8.7	7.1	7.8	10.8	9.0	7.6	6.5	97.1
Total	66.1	71.0	77.1	73.5	84.7	76.4	61.9	70.0	99.0	84.2	73.2	63.9	900.8
Grand Total	99.9	132.8	144.7	126.7	119.5	109.5	120.3	159.2	180.9	147.5	116.8	90.1	1,547.8

YSURA H.R : a group of small areas directly derived water from YSURA Head Race by private pipes.
YSURA area : including the extension area of about 1,140 ha out of 2,275 ha assuming that the half of the area is irrigated.
Area A1 : irrigation area in the reaches from VillarPando to Los Guiros up (Azua Irrigation District Zone)
Area B1 : irrigation area in the reaches from Los Guiros to Santana upstream
Area B2 : Santana irrigation area
Area B3 : irrigation area in the reaches from Santana downstream to Tomate-Mena upstream
Area B4 : irrigation area in the Tomate-Mena system
Area B5 : irrigation area in the reaches from Tomate-Mena downstream to Palo Alto upstream
Area B6 : irrigation area in the reaches from Palo Alto
Location of the irrigation areas is shown in Figure 3.5.2, 3.5.3, and 3.5.4.

3.5.5 Ongoing and Planned Irrigation and Drainage Projects

In the Study area, various irrigation and drainage projects are ongoing and actually planned.

(1) San Juan Irrigation District Area

In the San Juan Irrigation District area, Proyecto Desarrollo Agricola Sostenible (PRODAS) is ongoing in accordance with a loan agreement with IDB in 1994 and a loan agreement with FIDA in 1995. PRODAS is composed of six sub-projects. Of the six

sub-projects, irrigation and drainage projects are as follows:

(i) Project for the completion of Sabaneta Dam, which was completed in 1998.

(ii) Modernization of irrigation and drainage systems in the left bank of the San Juan River

(iii) Restoration of about 5,000ha of land containing salt in the right bank of the San Juan River

(iv) Institutional reinforcement of WUO, the Sabaneta Dam Irrigation committee

In addition, INDRHI has a plan to implement rehabilitation and improvement of the Mijo Irrigation system and to organize WUO to implement water management under Programa de Mejoramiento y Administracion de los Sistema de Riego (PROMASIR).

(2) Azua Irrigation District Area

There exist several on-going irrigation and drainage projects such as the Amiama Gomez Pump-up Irrigation Project, Biafara Irrigation Project, Drainage Improvement Project in YSURA canal system area and Groundwater Resources Investigation Project in Azua Plain. The Amiama Gomez and Biahara projects were almost completed in 1998. Both projects are planning to take water from the YSURA headrace. Total irrigation area is planned to be 2,160 ha. As for the drainage improvement project in Azua plain, the major scope of works is the strengthening of the existing YSURA Canal Irrigation Committee and the rehabilitation and improvement of drainage systems in YSURA. INDRHI is, however, reviewing the original development plan.

(3) Yaque del Sur Irrigation District and Lago Enriquillo Irrigation District Area

There are two on-going small-scale irrigation development projects in the Study area in Lago Enriquillo District. One is the Prolongation of San Ramon Canal (AGUACATICO), aiming to newly irrigate 750 ha in the Neiba plain. The other is the Alto Latuna Agricultural Development Project. The canal facilities are being constructed by INDRHI to develop 100 ha. Water will be derived from the lateral drain of Santana system. Besides, the groundwater investigation is being carried out in Neyba- Galvan.

3.6 Rural Infrastructure

3.6.1 Living Environment

The Study area is situated in a poverty zone and the living environment is recognized as one of the lowest levels in the country. The inhabitants suffer from not only insufficient housing facilities and amenities but also lack of basic human needs. Based on the Census in 1993, the condition of the rural infrastructure is tabulated in Table 5 and summarized as follows with the comparison to the national average:

	Water Supply	Electricity Supply	Sanitary Service	Rubbish Disposal Service
Azua area	64 %	70 %	48 %	72 %
San Juan area	55 %	62 %	37 %	68 %
Barahona area	76 %	90 %	53 %	81 %
Baboruco area	58 %	67 %	33 %	68 %
The Study area	62 %	71 %	44 %	73 %
National Average	67 %	82 %	56 %	88 %

Source: Census in 1993

3.6.2 Roads

Route 2 primary national road (Sanches Road) runs approximately through the center of the Study area from southeast to northwest, originating from Santo Domingo city, linking the cities of Azua, San Juan and further extending to Comendador in the west. Route 2 branches off some secondary national roads of Routes 41, 44, 48 and 50, leading to Constanza, Barahona, Neyba and El Cercado, respectively. A road map is shown in Figure 8 and the actual condition of the national roads within the Study area is summarized below.

Road Category	Total Length	Pavement
Primary national roads	225 km	100 %
Secondary national roads	425 km	67 %
Tertiary national roads	310 km	90 %
Rural roads*	1,018 km	47 %

Source: SEOPC, 1997

Remark: * Excluding farm roads, canal inspection roads and sugarcane roads

National roads are planned, constructed, and maintained by SEOPC and are recognized to be well maintained in relatively good condition, while roads in the rural and mountainous area are normally gravel or earth surface, affecting traffic condition especially during the rainy season.

3.6.3 Municipal Water Supply

The development and supply of drinking water in the Study area are the responsibilities of INAPA (Instituto Nacional de Aguas Potables y Alcantarillados) for both urban and rural areas under the supervision of SESPAS (Secretaria de Estad de Salud Publica y Asistensia Social). Since the 1970s, INAPA has put forth efforts to construct a number of drinking water supply systems of pipe line networks (called "acueducto"). There are 63 existing aqueducts, 22 wells with windmills (called "molino") and shallow tube wells with hand pumps.

Existing INAPA water supply systems are facing various problems, such as poor maintenance, insufficient discharge capacity against increasing beneficiaries and so on, therefore a large number of the rural people are suffering from the lack or shortage of well-treated water supply. In the Study area, there are still many communities sufferinging from the lack of a water supply system especially in the rural and mountainous area, where villagers' drinking water relies on rivers, canals, springs and pay water from suppliers. The condition of rural water supply in the Study area is summarized below.

Category	Azua prov.		San Juan prov.		Barahona prov.		Bahoruco prov.	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
INAPA water supply	73 %	58 %	82 %	39 %	81 %	52 %	64 %	51 %
(Each house)	64 %	45 %	68 %	26 %	65 %	40 %	54 %	32 %
(Public)	9 %	13 %	14 %	13 %	16 %	12 %	10 %	19 %
Other water source	27 %	42 %	18 %	61 %	19 %	48 %	36 %	49 %

Source; Census in 1993 Remark; Figures show the ratio by population

3.6.4 Electricity Supply

Electric supply and rural electrification is the responsibility of CDE (Corporacion Dominicana de Electricidad), besides development of hydroelectric power stations by INDRHI. The Study area is situated mainly in the south electrical zone of the CDE national grid and partly in the central Cibao zone (Constanza). The 138kV and 69 kV transmission lines, which cover the Study area, run along Route 2 and Route 44 connecting the Sabaneta, Sabana Yegua and Las Damas hydropower stations, Barahona thermal power station and Pizarrete and transformer substations. Their location map and inventory are illustrated in Figure 9.

Electrification in the rural area has not been attained sufficiently. In the Study area, only 68 % of household have electricity according to the census in 1993, in which 89% is in the urban area and 51% in the rural area. Power demand in the Area is steadily increasing compared with its generation. Actually, there is commonly power cut-off due to the power generation shortage. The supply losses including illegal distribution are increasing these years and improvement in supply reliability has not been realized.

3.6.5 Other Social Infrastructures

(1) School and Hospital

In the Study area, there exist 424 initial schools, 814 primary schools, and 69 secondary schools under the administration of SEEC (Secretaria de Estado de Educación y Cultos). The government health services are provided by SESPAS and there are 4 provincial hospitals and 87 rural clinics in the Study area.

(2) Community Center

In the Study area, only major towns have community centers which are provide spaces for the villagers' social activities such as various meetings and village level communications. In other villages in the rural area, community halls are not found but other places are utilized for social purpose, for example schools, churches, villagers' residences and some open spaces.

3.7 Agricultural Support Services

The related agricultural support service system at the national and regional level is depicted in Figure 10. In the Study area, agricultural support services are carried out mainly by the Ministry of Agriculture (SEA), National Institute of Hydraulic Resources (INDRHI), the Agrarian Institute (IAD), Agricultural Bank, the Institute for Cooperative Development (IDECOOP), and the Special Fund for Agricultural Development (FEDA), Price Stabilization Institute (INESPRE) and several NGOs. The ministry of agriculture

mainly plays a role in extension and research services, formulation of rural organization, tractor renting services, sale of farm inputs. INDRHI is resopnsible for the construction of irrigation facilities, operation and management of irrigation systems and training of WUOs. Agrarian Institute deals with transmigration program and the financial and technical support for the immigrants. The Agricultural Bank provides financial assistance mainly for farmer's procurement of inputs and agricultural equipment. The Special Fund for Agricultural Development provides financial services to the poorest farmers, and the Institute for IDECOOP promotes formulation of the cooperatives (including financial services). NGOs carry out provision of the small-scale agricultural financial and technical services to farmers.

3.7.1 Extension and Research

(1) General

The Undersecretary of Agricultural Research and Extension of SEA is responsible for the research and extension policy in the country. Research work is carried out through the agricultural research centers and extension work is carried out by through the national extension service system using regional offices and zones and areas.

(2) Overall Organizational Structures of Research Services

There are nine agricultural research centers in the country that make specific research work for food crop, agricultural mechanics, livestock, seeds, cocoa, alkaline soils and so on. In additions, there are the private institutions engaged in agricultural research like ISA,UASD,UNPHU, etc.

The total number of staff in the nine agricultual research centers is 101, and its budget in 1996 was around DR$31 million of which about 99 % is allocated to personnel expenses and only 0.8% to research materials. Because of lack of the governmental fund for research and low salary for researchers, the agricultural research centers cannot employ experienced researchers and the research activities are stagnated in fact. Under such circumstances, Agricultural Research Foundation (FDA) funded by the private sector plays an important role in prividing financial support on several research activities for the individuals and universities.

With respect extension service, the country is divided into 8 regional offices comprised of 2-3 provinces. Each regional office is subdivided into zones (regularly covering a Municipal Districts) and then each zone is further divided into sub-zones and areas. The annual budget allocated to the extension services in 1996 was DR$14.5 million of which 99 % was given to personnel expenses. The extension services to the farmers are inactive. In addition to SEA, there is some extension being done by the Agrarian Institute to the Land Reform Beneficiaries and by some agroprocessing plants and export companies providing technical assistance to farmers.

(3) Present Condition of Extension ServicesAgricultural Offices in the Yaque del Sur River Basin

In the Study area there are two regional offices (south and south-east region), four

provincial offices (Azua, San Juan, Barahona and Bahoruco Provinces) and 18 sub-zonal offices. There are 178 extension workers who are not always trained. The 60 % of the extension workers graduated from university and the others graduated from agricultural technical schools. The curriculum in the universities and the agricultural technical schools are too old to be applicable to present agriculture. In addition, because of lack of the budget for extension works, the extension workers cannot take the fundamental education services of extension works, i.e. proper farm practices, water management, extension method, administrative management, formulation of organization, so the technical level of the extension workers is so low. It is necessary to educate such extension workers appropriately and improve the quality of the workers.

The total number of the farmers in the Study area is estimated around 70,000, so work load of one extension worker is 400 households of the farmers. In terms of the area, the total cultivated area is estimated to be 117,000 ha including 71,000 ha of irrigation land and rainfed land without shifting cultivation areas, so the area per a extension worker is around 650 ha, which is quite large. At present the extension services is carried out to not groups but individuals, thus it is difficult to execute the proper extension services.

The authorized systematic methodology for performance of extension services and proper management for extension workers are not established at present, so the high quality of extension services can not be carried out. There are no regularly scheduled visits to farmers along with a shortage of extension kids and materials. Shortage of transport means is one of the constraints for hampering effective extension work. Facilities for extension offices in the Study Area include are shown below 14 light trucks, 58 motorcycles, 4 jeeps, 1 computer, 60 file cabinets, 34 typewriters, 106 desks and 81 chairs.

(4) Present Conditions of Research Services in the Yaque del Sur River Basin

In the Study area there are two agricultural research centers such as the Southwest Agricultural Center (CIAS) at Arroyo Loro in San Juan Province and the Center for Agricultural Research in Arid Zones (CIAZA) in Azua Province, and an experimental farm at Palo Alto in Barahona Province under SEA. In the experimental farm (18.8 ha), cassava and plantain are planted, but the research work has not been taken place. The irrigation facilities in the experimental farm are damaged and needed to be repaired.

CIAS is devoted to research mainly in variety tests of red bean, and in tests of beans requested by PRODAS and foreign private firms on a contract basis. CIAZA examines mainly variety tests of pigeon pea and pest and diseases control test for tomato, sweet potato and plantain. However, CIAZA does not have any contract research work from the projects or other foreign firms. Because of lack of budget allocated from the government and no any revenue from contracts, activities of research work in CIAZA was nearly closed down and is now trying to find method for its revitalization. Staffing is insufficient. There are only a main researcher and two researchers with master degrees in CIAS. There is no researcher with a higher degree and only 10 Agricultural engineers. Equipment for research work is insufficient in CIAZA.