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Japan International Cooperation Agency (JICA)

National Irrigation Administration (NIA)
Government of the Republic of the Philippines

THE STUDY ON JALAUR IRRIGATION SYSTEMS AND RURAL AREA DEVELOPMENT PROJECT IN THE REPUBLIC OF THE PHILIPPINES

VOLUME-II

ANNEXES

June 1998

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Exchange Rate

US$ 1 = P 26.0 (As of March 1997)

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ANNEX A

Master Plan

on

Selection of Priority Projects

in Phase I

THE STUDY ON JALAUR IRRIGATION SYSTEMS
AND RURAL AREA DEVELOPMENT PROJECT

ANNEX A

Master Plan Study on Selection of Priority Projects in Phase I

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1. INTRODUCTION

1.1 Authority

This ANNEX-A presenys the results of all works performed in both Philippines and Japan during Phase I Study, focusing the main activities on preparation of master plan study of all the five (5) existing national irrigation systems (NIS), and evaluation and selection of priority projects for which the feasibility study will be made during Phase II Study.

1.2 Works performed in Phase I Study

1.2.1 General

The activities of the study team in the Phase I study were composed of: (i) preparatory works in Japan from December 10 to 21, 1996; (ii) field works in the Philippines from January 8 to March 23, 1997; and (iii) office works in Japan from May 9 to July 7, 1997.

1.2.2 Preparatory Works

For smooth and efficient execution of the Study, the following works were carried out in Japan prior to the departure of the study team to the Philippines:

- examination of available data,
- preparation of a plan of operation for the Study, and
- preparation of the Inception Report.

A meeting was held on December 17, 1996 between the advisory team and study team to discuss the contents of the Inception Report, mainly for the plan of operation and work schedule of the field survey.

1.2.3 Field Works in the Philippines

The advisory team and the first group of the study team arrived in Manila on January 8, 1997, and had an inception meeting with NIA on January 10, 1997. During the period of the site visit from January 12 to 14, 1997, a meeting on the Inception Report was again held among NIA Central Office, NIA Region VI Office, regional offices of the government agencies concerned, local government offices concerned, the advisory team and the study team on January 14, 1997. Through these meetings, the Inception Report was basically accepted by NIA and the Minutes of Meeting were signed between NIA and the study team in the presence of the advisory team on January 16, 1997.

After the above-mentioned meetings, all the experts of the study team commenced their respective field works including field reconnaissance, data collection and analysis, field investigation, preliminary study on present conditions of meteo-hydrology, socio-economy, agriculture, irrigation and drainage, water management, watershed management and environment in and around the study area, and establishment of the basic concepts for formulation of development plan. In addition, the aerial photograph shooting and preparation of photo-mosaic maps, hydro-geological investigation and water quality survey were also executed under sub-let contract basis. These survey and study results were compiled in the Progress Report(I) which was submitted to NIA on March 17, 1997. In order to discuss the contents of the Progress Report(I), meetings with NIA were held at Iloilo and Manila on March 17 and March 19, 1997, respectively. Through these meetings, the Report was basically accepted by NIA.

1.2.4 Office Works in Japan

The office works of the Phase I study in Japan were carried out from May 9 to July 7, 1997. The works included: (i) review and analysis of the data and information collected in the field works; (ii) study on project development plan including the improvement plan of irrigation and drainage facilities, irrigated agriculture development plan, improvement plan of rural infrastructures, improvement plan of water management, improvement of agricultural support services, improvement plan of strengthening of farmers' organizations and NIA, improvement plan of post-harvest facilities and marketing, and development plan of watershed management; (iii) environmental consideration; (iv) preliminary estimate of project cost; (v) project evaluation; and (vi) study on priority of the development and project implementation. The results were compiled in this Annex-A. It is noted, however, that such study results will be reviewed and finalized on the basis of the subsequent field works in Philippines as well as the office works in Japan during Phase II Study.

2. REVIEW OF PROJECTS RELATED TO THE STUDY

2.1 Jalaur River Multipurpose Project

The Jalaur River Multipurpose Project (JRMP) is a scheme aiming at a year-round water supply for irrigation, power generation and municipal and industrial use by utilizing the water of the Jalaur river. The feasibility study on JRMP was completed in 1976 with a financial assistance from the World Bank. The implementation of JRMP was proposed to be divided into two (2) stages ; Stage I-rehabilitation and improvement of the existing irrigation systems such as Aganan , Sta. Barbara , Suague and Jalaur (so called Jalaur proper) with a total area of some 22,000 ha and construction of new irrigation and drainage facilities for an extension area of about 2,700 ha to the Jalaur River Irrigation System (so called Jalaur extension), and Stage II-construction of high storage dam, power plant and transbasin diversion channel.

The project works for Stage I were completed in 1983 at a cost of 202.2 million peso with a financial assistance from the World Bank. In 1988, an evaluation and updating of the previous study was carried out and found that the revised EIRR was a low 6.7 %. The study concluded that Stage II could not be economically justified unless the plan be modified significantly.

NIA formulated an alternative plan. Consequently, the said plan has replaced the proposed multipurpose dam by several small impounding dams to be located in the upper catchment of the existing NIS with the sole purpose of irrigation. The extension areas of 5,800 ha in total which would be irrigated by using water from a proposed transbasin diversion channel (so called low line canal) in the feasibility study were still included in the alternative plan. Thus, the possibility of irrigated agriculture development for the said extension areas would be clarified in the Study.

2.2 Agricultural Development Project for Aganan River Irrigation Area

The Agricultural Development Project for Aganan River Irrigation Area (the Project) was completed under Japan's Grant Aid Program and turned over to the Philippine Government from Japan Government at the end of March 1996. The project area is located on the right bank of the Aganan river adjacent to the western area of Iloilo city in Iloilo province.

The objectives of the Project were:

(i) improvement of agricultural productivities ;
(ii) improvement of farm income ;
(iii) activation of IAs ; and
(iv) efficient utilization of water and land resources.

The Project included the following components :

(a) <u>Improvement of the existing irrigation facilities of the Aganan RIS</u>: improvement of the diversion dam and rehabilitation of irrigation canal structures and service road ;
(b) <u>Construction of the post-harvest facilities</u> : multipurpose pavement, glass house, paddy warehouse , administration office and equipment shed ; and
(c) <u>Procurement of the O&M equipment</u>: equipment for O&M of the irrigation facilities and equipment for O&M of the post-harvest facilities.

The effects and impacts of the Project were preliminarily evaluated in the Paper prepared by NIA in January 1996, which are summarized as follows:

(a) Improvement of the existing diversion dam

Before the commencement of the Project, the right bank downstream of the diversion dam was very seriously eroded by floods and the erosion was about to destroy the existing main canal and dam itself. With the improvement of the diversion dam, the dam and main canal turned safe against floods and actually were saved from the extraordinary flood which occurred on October 28 and 29 in 1995 (a 200-year probable flood).

(b) Concrete lining of the main canal

Before the commencement of the Project, the main canal was made of earth and irrigation water could hardly reach paddy field even in the wet season because of i) low velocity of the flow caused by rough and irregular canal sections and ii) seepage loss from the canal. With the concrete lining of the main canal, the irrigation water reached the field faster and smoothly. Before the Project, it took about 6 months to deliver the irrigation water and complete one cropping period for the whole service area of the system. Owing to the concrete lined canal, it took only 4 months.

(c) Post-harvest facilities

The following conditions of post-harvest facilities were clarified through the field survey :

Utilization of Post-harvest Facilities
(April 1996 to December 1996)

Paddy stored in Warehouse	:	4,087 sacks for 34 persons
Dry Yard	:	13,070 sacks for 100 persons
Transportation by Cargo Truck	:	20,000 sacks for 100 persons
Plowing by Farm Tractor with Rotavator	:	318 ha for 212 persons

Income by Post-harvest Facilities
(April 1996 to December 1996)

Paddy Warehouse	:	3,389 pesos (0.59 %)
Dry yard	:	13,070 pesos (2.26 %)
Cargo Truck	:	19,989 pesos (3.46 %)
Farm Tractor with Rotavator	:	541,683 pesos (93.69 %)

As shown in the above table, the paddy warehouse is not used effectively. The effective utilization plan of post-harvest facilities, especially paddy warehouse, shall be studied in the Study on the basis of constraints and problems found through the field survey.

2.3 The Study on the Flood Control for Rivers in the Selected Urban Centers

The objectives of the Flood Control Study were :

(i) to collect and compile the existing data on representative medium and small-scale rivers in thirteen (13) urban centers and prepare a river inventory based on the aforementioned data ;
(ii) to formulate a master plan on flood control for rivers located in the four (4) cities considered as priority areas for the Master Plan Study ;
(iii) to conduct a feasibility study on the most urgent flood control project identified in the Master Plan ; and

(iv) to carry out transfer of technical knowledge to Philippines counterpart personnel concerned through the foregoing series of studies and project formulation in the Philippines and in Japan.

Through the inventory survey, the rivers located in the four (4) cities considered as priority areas were selected for a master plan on flood control. The flood control project works proposed in the master plan are summarized as follows :

City	Project Works	Work Quantity		Major Structure
Ioilo	river improvement	Jaro	: 18.9 km	rivetment , bridge , etc.
		Iloilo	: 6.5 km	rivetment , bridge , etc.
	construction of floodway	Jaro	: 4.8 km	diversion channel
		La Paz	: 0.6 km	diversion channel
	drainage improvement	3 channels	: 10.0 km	
Cebu	river improvement	Bulacao	: 2.7 km	rivetment, drop, bridge
		Kinalumsan	: 4.0 km	retaining wall,drop,bridge
		Guadalupe	: 4.0 km	retaining wall,drop,bridge
		Lahug	: 5.0 km	retaining wall,drop,bridge
		Subang Duku	: 5.5 km	retaining wall,drop,bridge
	drainage improvement	9 channels	: 10.9 km	
Ormoc	river improvement	Anilao	: 1.8 km	rivetment,drop,bridge,slit dam
		Malbasag	: 1.9 km	retaining wall,drop,bridge
	drainage improvement	2 channels	: 1.8 km	
Tacloban	drainage improvement	7 channels	: 15.9 km	

Among the flood control plans on four (4) cities in the master plan, the urgent flood control plans for such two (2) cities as Iloilo and Ormoc were selected by taking into account the following :

(i) Urgency in implementation to mitigate flood damage;
(ii) Higher economic efficiency;
(iii) Less negative impacts on environmental condition; and
(iv) Less obstacles and social problems in implementation due to land acquisition and resettlement of inhabitants.

The flood control project works proposed in the urgent plan are summarized as follows :

City	Project Works	Work Quantity		Major Structure
Iloilo	river improvement	Jaro	: 7.22 km	revetment, 2 bridges
		Iloilo	: 6.50 km	revetment , 4 bridges
	construction of floodway	Jaro	: 4.80 km	diversion channel
	drainage improvement	3 channels	: 9.65 km	
Ormoc	river improvement	Anilao	: 1.80 km	revetment,3drop,2bridge,2slit dam
		Malbasag	: 1.90 km	retaining wall,4drop,2bridge,1slit dam
	drainage improvement	1 channel	: 1.20 km	

In the Urgent Flood Control Plan, the following project works were proposed :

(i) construction of Jaro Floodway;
(ii) partial improvement of the Jaro river; and
(iii) improvement of the Tigum and Aganan rivers.

The proposed Jaro Floodway with a flow capacity of 850 m^3 was planned to run across the irrigation service area of Sta. Barbara RIS divided into two areas, such as northern area and southern area. However, the southern service area has been mostly converted into subdivisions or residential areas. The area of only 20 ha would remain as irrigation service area if the said floodway would be constructed. Under such a situation, the above construction plan of Jaro floodway would have no great influence on the development/improvement plan in the Study. If the improvement plans of the Jaro, Tigum and Aganan rivers would be implemented, the present drainage and flooding conditions in the Aganan and Sta. Barbara RIS areas would be drastically improved.

2.4 First Irrigation Operations Support Project (IOSP I)

The First Irrigation Operations Support Project(IOSP I) financed the first phase of NIA's nine-year Irrigation O&M Improvement Program, which commenced in July 1988, and was the first-financed project in the Philippines primarily to address O&M of irrigation systems.

The main objectives of IOSP I were:

(i) to strengthen the institutional and technical capability of NIA and cooperating IAs in order to improve and maintain the efficiency of existing NIA infrastructure, and
(ii) to improve the operating performance of the 127 existing NISs through minor repair works and through increase in the annual funding for O&M services and levels of O&M services.

IOSP I covered all of the existing 127 NIS. IOSP I components included:

(a) Institutional Strengthening of NIA to Provide Improved O&M Services,
(b) Acceleration of NIA's Irrigators' Association(IA) Development Program,
(c) Execution of Minor Rehabilitation, and
(d) Execution of an Expanded Operation and Maintenance Program.

The following works were executed under IOSP I for NIS in the study area.

(a) Restoration works

The restoration works were desilting, weeding and clearing, repairs of service road, and repairs of canal structures including gates. The allocated budget for the restoration works is shown below. Most of budget was used for the desilting works on the irrigation canals.

Budget Allocation for Restoration Works

(Unit : peso)

Year	Aganan & Sta. Barbara RIS	Jalaur & Suague RIS
1989	2,105,700	3,288,000
1990	3,532,030	3,580,163
1991	2,420,300	529,600
Total	8,058,030	7,397,763

(b) Recurrent works

The recurrent works were also the same as the restoration works, mainly of irrigation canal systems including service road damaged by typhoons and floods. The allocated budget for the recurrent works is as follows :

Budget Allocation for Recurrent Works

(Unit : peso)

Year	Aganan & Sta. Barbara RIS	Jalaur & Suague RIS
1989	747,700	1,594,600
1990	250,000	3,062,656
1991	592,000	500,000
Total	1,589,700	5,157,256

2.5 Second Irrigation Operations Support Project (IOSP II)

The project aims to improve and sustain the operational efficiency of the NIS, thereby helping increase agricultural production (mainly rice), expanding small farmer incomes and rural employment opportunities, and contributing to rural poverty alleviation.

The project would finance the second phase of the program launched under IOSP I on the national irrigation systems , through:

(i) improvement of 18 NIS, urgent repairs in another 14 NIS , construction of three sediment exclusion structures and a few improved water control structures on a pilot basis , and erosion prevention measures in critical areas;
(ii) continued support of the improved system-level operation and maintenance (O&M) achieved under the IOSP I and of measures to ensure their sustainability ;
(iii) establishment of new IAs, and enhanced financial and management training of the IAs to facilitate progressive turnover of system O&M to them; and (ii) strengthening of NIA through support to improve ISF collection; staff training on O&M, appropriate engineering design techniques, administrative and financial aspects of systems management, and farmer training techniques; technical assistance for studies, IA development work and staff training; and provision of high priority O&M equipment and materials; and
(iv) strengthening agricultural support services, including research and extension, farmer training in integrated pest management, and promotion of IA-based seed production.

The project would be implemented over a five and a half year period (mid-1993 to end-1998). It would be nationwide in scope and cover all 165 of the existing NIS serving about 620,000 ha.

The following works were executed under IOSP II for NIS in the study area.

(a) Repair works

The works included repairs of canal systems and service roads.

(b) Canal maintenance works

The canal maintenance works were executed for incremental O&M of canal system. The works were desilting, raising of embankment, improvement of canal structures including repair of control gates, and support for salaries and allowances of Institutional Development Officer (IDO).

(c) Urgent repair works

The urgent repair works were executed for the diversion dams of the Sta. Barbara RIS and Suague RIS which had been damaged mainly by floods. These urgent repair works were done on contract basis. These involved river training works upstream of the dams, and improvement and repair works of retaining wall, apron and concrete blocks downstream of the dams including repair of steel gates.

The allocated budget for the above works is shown below.

Budget Allocation

(Unit : peso)

Year	Aganan & Sta. Barbara RIS			Jalaur & Suague RIS		
	Repair	Canal M.	Urgent R.	Repair	Canal M.	Urgent R.
1993	1,652,236	1,215,350	-	1,705,089	1,412,800	-
1994	320,300	645,040	-	-	1,130,940	-
1995	727,060	1,635,317	14,110,000	2,145,024	1,910,000	-
1996	n.a.	n.a.	n.a.	n.a.	n.a.	12,363,000
Total	2,699,596	3,495,707	14,110,000	3,850,113	4,453,740	12,363,000

2.6 Water Resources Development Project

The Water Resources Development Project (the Project) is a follow-up project to IOSP II to continue the program approach to irrigation systems improvement and repair. The Project would assist the Government in developing an appropriate policy and institutional framework to improve water resources planning, development and management in the country through the following:

(i) to initiate an integrated and comprehensive approach to watershed management to sustain water sources,
(ii) to improve efficiency of existing systems, thereby increase agricultural production (mainly rice) and finally alleviate rural poverty,
(iii) to improve irrigation services in the long term by accelerating management turnover of irrigation systems to water users and by increasing NIA's institutional effectiveness, and
(iv) to improve the environment in irrigated area, mainly by controlling schistosomiasis, a water-borne disease.

The Project would include the following components:

(i) improved water resources planning and management which include preparation of a national water resources plan, improvement of national data collection networks, establishment of a national water information network, and strengthening of NWRB,
(ii) improved watershed management which consists of formulation of a national watershed management strategy and investment, and institutional strengthening program, investments for improved management of a few high priority watersheds and training/study tour for DENR and NIA staff relating to watershed management program in other countries,
(iii) improvement and repair of NIS which include improvement of 14 systems, repairs to either major structures in other 14 NIS, and strengthening of Masiway dam and construction of sediment exclusion structures in another five NIS,
(iv) institutional strengthening of NIA and IAs which includes provision of staff training, consultancies, and computers for strengthening of NIA, and strengthening of IAs through provision of training, consultancies and

incremental operating cost to facilitate progressive management turnover of systems to them, and

(v) environmental improvement which consists of control of schistosomiasis in 3 NIS, erosion control works in 31 NIS, sediment monitoring in 3 NIS, and establishment of an Environment Unit within NIA and provision of training and consultancy to the Unit.

The Project would be implemented for five years from 1997 to 2001.

In the project component on improvement and repair of NIS, the following works are proposed for improvement and repair of Jalaur proper RIS.

Work Items in Jalaur Proper RIS

Work Item	Main	Laterals
Service Road	2.1km	46.18km
Replacement of Steel Gate	33unit	77unit
Desilting	14.25km	63.09km
Embankment Raising	2.37km	23.78km
Structure Repair	4unit	40unit
Grouted Riprap	390m^3	1,624m3

Total cost of the above works is estimated at 29,462.6 thousand pesos (US$ 1,031.8 thousand).

The above works should be excluded in the improvement plan of the canal systems of the Jalaur proper RIS in the Study.

3. PRESENT CONDITIONS OF THE STUDY AREA

3.1 Location

The study area is located in Iloilo province in the island of Panay. It lies within the coordinates 10°37'50" and 11°00" east longitude and 122°38' to 122°45' north latitude, and its borders are defined by Jalaur damsite and the municipalities of Dueñas and Lambunao on the north, the municipalities of Leon and Maasin on the west, the city of Iloilo and Guimaras island on the south, and the municipality of Barotac Viejo on the east. It is situated north and northeast of Iloilo city, the provincial capital of Iloilo and the regional center of Region VI (Western Visayas). It covers 13 municipalities, namely; Leganes, Oton, Pavia, San Miguel, Sta. Barbara, Anilao, Barotac Nuevo, Dingle, Dumangas, Mina, New Lucena, Pototan, and Zarraga, and the northeastern part of Iloilo city comprising 10 barangays.

3.2 Demography

The study area encompasses 217 barangays belonging to 13 municipalities and the city of Iloilo with a combined population of about 392.2 thousands in 1995. The population density is estimated at about 4 persons per ha, or roughly 20 percent higher than the provincial average. This situation partly accounts for the large population in the barangays of Iloilo City and Pavia covered by the Study which have an estimated population density of 59.7 and 7.6 persons per ha, respectively. The small average size of land (about 1.5 ha) distributed to farmers under the Comprehensive Agrarian Reform Program (CARP) also partly explains for the present population density in the study area.

The demographic characteristics of the study area are summarized in the following table, with comparative data at the provincial, regional and national levels:

Comparative Demographic Factors

Parameters		Study Area	Iloilo Province	Region VI	Philippines
Area	('000ha)	42.9	532.4	2,022.3	30,000.0
Population	('000, 1995)	392.2	1,,876.0	5,777.0	68,614.2
Population density	(Persons/ha, 1995)	4.2	3.5	2.8	2.3
Average family size	(Number)	5.2	5.5	5.5	5.3
Population growth	(%/year, 90'-95')	2.0	2.1	1.8	2.3

Source: National Statistical Coordination Board, 1996 Philippine Statistical Yearbook and 1995 Regional Social and Economic Trends: Region VI (Western Visayas). The population density for the Study Area was computed by dividing its estimated population of 392,244 by the total land area of the 15 municipalities and Iloilo City served by five RIS (92,870 ha).

3.3 Social Structure and Economic Condition

3.3.1 Social Structure

The structure of society in the Study Area can be characterized by polarity. On one end are the small number of farmers who owned relatively big tracts of land consisting mainly of absentee landowners and owner-noncultivators. On the other extreme are the leaseholders and tenant farmers. This polarized condition is very evident in Aganan, Jalaur proper and Jalaur extension RIS, and is partly illustrated by the results of survey with IA Presidents as shown below. About one-fifth (19 percent) of farm households do not own the land they till.

Number and Average Irrigated Farm Area of Farm Households in the Study Area

River Irrigation System	Absentee Landowners		Owner Non-cultivators		Owner Cultivators		Leaseholders		Tenant Farmers		All farmers	
	No.	Farm Area	No.	Farm Area	No.	Farm Area	No.	Farm Area	No.	Farm Area	No.	Farm Area
Aganan	119	2.08	340	1.63	545	1.57	719	2.02	291	2.04	2,014	1.78
Santa Barbara	17	3.18	140	1.61	515	1.65	763	1.43	10	6.70	1,445	1.59
Jalaur Proper	73	3.74	155	5.77	606	3.52	1,491	2.01	649	2.69	2,974	2.63
Jalaur Extension	60	2.00	183	2.35	358	1.55	770	0.96	368	0.94	1,739	1.25
Suagu	61	2.95	72	1.36	153	2.71	893	1.35	591	1.63	1,770	1.61
TOTAL	330	2.65	890	2.48	2,177	2.20	4,636	1.61	1,909	1.95	10,012	1.88

Average farm area (ha) = Total irrigation area (ha)/Total number of farm households by type of farmers.
Source: Results of survey with IA Presidents conducted from 31 January to 26 February 1997. No response was received from two IA Presidents, one each from Aganan (JIPADUSA) and Sta. Barbara (TACAS-BUHANG).

3.3.2 Socio-Economic Situation

The economy of the study area is generally dominated by agriculture with paddy rice as the main crop produced. Its economic condition is typical of most parts of Iloilo Province, except those municipalities adjacent to Iloilo City such as Pavia and Leganes where urbanization due to expansion of the city has reduced gradually the irrigated agricultural land every year. As a result, a shift in cropping system towards diversified, high-valued crops has occurred in Aganan-Sta. Barbara RIS service area. The economic indicators for the study area are summarized below, with comparative data for provincial, regional and national levels.

Indicators		Study Area*	Iloilo Province	Region VI	Philippines
Labor force	('000)	239	1,200	2,551	28,057
Employed population	('000)	104	666	2,324	25,700
Share of agriculture sector	(%)	64	43	53	44
Employment rate	(%)	83	78	91	92
Unemployment rate	(%)	17	22	9	8
Average income	(Pesos)	32,400	43,104**	47,724**	65,186**
Average expenditures	(Pesos)	30,800	37,633**	42,671**	51,991**

Source: National Statistical Coordination Board, 1996 Philippine Statistical Yearbook for regional and national data; and NSCB, 1995 Regional Social and Economic Trends: Region VI (Western Visayas) for provincial data.
* Municipal-level data. ** 1991; others are in 1995.

Estimates on average family income and expenditure based on the results of the socio-economic survey are still being investigated for consistency of data coding and encoding. Available data at the municipal level indicate that the average per capita income was about 2,000 pesos in 1994, compared to the per capita poverty threshold of 3,300 pesos for the same year. For the municipalities concerned, except the city of Iloilo, the poverty incidence has ranged from 71.4% to 83 % in 1994.

3.4. Natural Conditions

3.4.1 Topography

The Study area is located in the alluvial plains of the two (2) rivers, namely Jalaur and Jaro rivers. Majority of the study area are covered by the irrigated paddy field and rainfed paddy field. The upland areas with small undulation and slopes are found around the northern and western boundaries of the Study area. The undulation areas are not so much expanded in the alluvial plain areas.

The Jalaur river has two (2) big tributaries, namely, Suague and Jagdong rivers, and the Jaro river has also two (2) tributaries, namely Tigum and Aganan rivers. All the rivers originate near the mountain chain which includes the peaks as Mt. Baloy, Mt. Singit, Mt. Inaman and Mt. Tambara. The mountain chain has an altitude of more than

1,000 m, and is laid with the direction of the north - south. All the rivers flow down to the eastern coast with the steep gradient, and flow out in the central area of the flat plain.

The elevation of thestudy area ranges from approximately 25 to 50 m around the diversion dam sites of the respective RISs areas, and the irrigation areas expand into the lowland located near the fish pond, the towns and build-up areas.

Thestudy area is almost covered by silty to clayey soils and drainability of the soils is generally poor, and small inundation occurs in the tail portion of the RIS areas due to the poor drainage system and flood from the big rivers during the rainy season.

3.4.2 Climate

(1) General

Climate in the Philippines is classified into four (4) types from Type I to Type IV (so called Coronas Climate Classification), authorized by the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), which is also used to verify the climatological suitability for agriculture (ref. Figure A.3.1).

The study area belongs to Type I or Type III which is defined as follows:

Type I Two pronounced seasons; dry from November to April, wet during the rest of the year.

Type III Seasons not very pronounced, relatively dry from November to April and moderate during the rest of the year

(2) Climate in the study area

Climatological normals at Iloilo (1961-1995, PAGASA) show the general climatological conditions in the study area.

Month	Rainfall (mm)	Rain days (nos.)	Temperature (Deg. C) Max.	Min.	Mean	Relative Humidity (%)	Wind Direction	Speed (m/sec)	Cloud (Oktas)
JAN.	39.4	8	29.8	22.7	26.2	82.0	NNE	5.0	5
FEB.	23.9	5	30.4	22.8	26.6	80.0	NNE	5.0	5
MAR.	29.6	5	31.7	23.4	27.6	75.0	NNE	5.0	4
APR.	50.9	5	33.1	24.6	28.9	73.0	NNE	4.0	4
MAY	118.2	10	33.2	25.1	29.1	76.0	SW	3.0	5
JUN.	303.8	19	31.6	24.7	28.2	82.0	SW	3.0	6
JUL.	340.4	20	30.7	24.4	27.6	84.0	SW	3.0	7
AUG.	383.6	20	30.5	24.5	27.5	84.0	SW	4.0	7
SEP.	285.6	19	30.8	24.3	27.6	84.0	SW	3.0	7
OCT.	268.3	18	31.1	24.2	27.6	84.0	N	3.0	6
NOV.	176.2	14	30.9	24.0	27.5	84.0	NNE	3.0	6
DEC.	84.6	11	30.2	23.3	26.8	83.0	NNE	4.0	5
Annual	2104.5	154	31.2	24.0	27.6	81.0	NNE	4.0	6

Source: PAGASA, Iloilo

During wet season (May to November), south-westerly monsoon wind prevails bringing 90 % of annual rainfall, while north-easterly monsoon wind during dry season (December to April) blows stronger and brings little rainfall. It is notable that annual rain days total to over 150 days, i.e., more than 40 % of the year. Even during the driest month, the study area receives a few days of rainfall which facilitates crop cultivation to a large extent.

3.4.3 Hydrology

(1) Rainfall

In Panay island, there are 16 authorized raingauge stations, of which only four (4) stations are active at present. They are Miagao (PAGASA), Iloilo Airport (PAGASA), Roxas City (PAGASA) and Dongsol, Pototan (NIA) (Ref. Table A.3.1). Taking into consideration their locations and periods of observation, several raingauge stations were selected for hydrological quantitative assessment. The Valderrama station was selected for representing bigger precipitation in upper river basins, while the Barotac Viejo station was selected to represent smaller precipitation in eastern part of the service area and the Jalaur River basin. Miagao, Iloilo Airport, and the Dongsol stations were selected to represent the service area's rainfall. Thiessen polygons were generated based on these raingauge stations as shown in Figure A.3.2. Catchment rainfall for each river system is synthesized based on the Thiessen polygon rainfall. Monthly rainfall records at Dongsol, Iloilo city, Miagao and Valderrama are given in Table A3.2, while synthesized catchment rainfall for each RIS is shown in Table A.3.3.

Rainfall distribution in the study area shows that precipitation is more in north-western part (over 3,000 mm) and less in south-eastern part (less than 1,500 mm). Since there is no rainfall data available on the western mountain side of Iloilo province, the study team installed an automatic raingauge recorder at Lambunao.

Rainfall at Dongsol which is situated in the service area of the Jalaur proper is summarized below:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean	51.0	27.2	36.6	60.4	72.3	259.5	300.2	310.8	240.4	269.0	189.6	88.0	1905.3
80% reliable	19.1	2.7	0.9	4.6	16.7	151.5	184.6	160.3	127.8	177.0	82.1	41.3	968.6

Source: NIA Region VI office
Note: Period 1977 - 1996

The rainfall in the service area is comparatively abundant and gives higher effective rainfall. Even during the dry season, rainfall of five (5) days or more is observed, which mitigates risk of damages to dry season's crops.

(2) Rivergauge record

In Iloilo province, there are 15 rivergauge stations, of which five (5) active stations are located upstream of the existing headworks of Jalaur and Suague: two (2) along the Jalaur River (Passi and Calinog), two (2) along the Ulian River (Dueñas and Lambunao), and one along the Suague River (Mina). These rivergauges are maintained by DPWH. Reliability of the data is somehow vague mainly due to system constraints. River discharges which are derived from the rivergauge records are available only up to the 1980s.

River discharges were measured using a current meter during this study period to verify the general runoff characteristics of the water source rivers. Locations of rainfall stations, rivergauges and discharge measurement points are shown in Figure A.3.3.

(3) Hydrological characteristics

(a) Jalaur River

The Jalaur River has ideal hydrological conditions with high stream order, well-shaped and vast catchment of 1,065 km^2 at the intake. The catchment area at the uppermost accessible point for vehicles of the Jalaur River at Alibunan is

120 km^2. Jalaur multipurpose dam (CA=109 km^2) was proposed at 2.5 km upstream from this point.

Most of the suspended sediment at the Jalaur headworks seems to originate from the river banks along meandering river courses upstream. Duration of high flow after precipitation of 10 to 20 mm in the catchment is more than one week.

River profile and the catchment are shown in Figure A.3.4.

(b) Ulian River

The Ulian River, one of the tributaries of the Jalaur River, also has good basin conditions. The catchment area at the uppermost accessible point for vehicles is comparatively big at 90 km^2. Present discharge at the proposed dam site (CA=96 km^2) is observed at 5.0 to 6.0 m^3/sec. Its wide river course and bigger size of river bed materials indicate a high specific runoff during wet season.

Duration of high flow after precipitation of 10 to 20 mm in the catchment is about one week.

River profile and the catchment are shown in Figure A.3.5.

(c) Suague River

Mainly due to upstream water use for 1,000 ha of paddy fields, discharge at the Suague headworks is very low compared to its catchment area (CA=181 km^2). However, the duration of high flow after intensive rainfall is longer, i.e. 4 to 7 days along mid-to-downstream (Janiuay to Mina) stretch. It is also observed that the upstream paddy fields retain or retard runoff to the downstream reaches. Consequently, the quantity of available water is insufficient during the dry season to irrigate the whole Suague RIS, of which the designed diversion discharge is 4.5 m^3/sec.

River profile and the catchment are shown in Figure A.3.6.

(d) Tigum River

The watershed of the Tigum River has been declared as a protected forest reserve and selected as the main source of potable and industrial water for Iloilo City. The catchment area at the uppermost reachable point for vehicles is 65 km^2, while estimated low flow during the dry season is more than 1.0 m^3/sec. Suspended sediment during the dry season is quite small, which is in sharp contrast with that in the Aganan River. A one-week duration of high flow after intensive rainfall has been observed.

River profile and the catchment are shown in Figure A.3.7.

(e) Aganan River

The Aganan River has the worst watershed condition in the study area. It is due to its topographic characteristics such as long and narrow shape, steep longitudinal gradient and less stream order; and is compounded by artificial devastation. Felling of trees for firewoods and cultivation of maize on the hillside are prevalent. Consequently, floods and sediment load of the Aganan River are bigger compared to its catchment area. The Aganan River is not considered a viable water source for irrigation because of its erratic river flow and high sediment load. Thus watershed management is recommended prior to water resources development.

River discharge at Alimodian (CA=87 km^2) has already dropped below 0.5 m^3/sec even without the major upstream water use. Duration of high flow after intensive rainfall is very short, i.e. one to three days. The catchment area at the uppermost reachable point for vehicles is about 20 km^2.

River profile and the catchment are shown in Figure A.3.8.

3.4.4 Water Resources

(1) General

In terms of irrigation water source, there are four river systems in the study area. They are the Jalaur River (including the Ulian River), the Suague River, the Tigum River and the Aganan River. Catchment areas at the existing diversion headworks are 1,065 km^2 for Jalaur, 181 km^2 for Suague, 193 km^2 for Tigum and 104 km^2 for Aganan.

(2) Runoff and water use by river system

(a) Jalaur River

Runoff records at the Jalaur diversion headworks are shown in Table A.3.4 (1/4) and summarized below:

(unit: m^3/sec)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean	42.3	28.2	21.1	20.8	28.4	43.9	65.5	58.6	53.7	79.3	79.5	71.2
80% reliable	15.6	13.9	8.0	5.3	10.7	26.7	34.5	29.1	31.3	47.5	39.8	28.8

Source: NIA, DPWH Region VI office
Note: Period 1949 - 1971

No authorized runoff records being available since the year of 1972, rainfall-runoff correlation was examined in order to know runoff conditions in recent years. Taking into consideration the seasonal variation of runoff coefficient, correlations were examined by season as shown in Figure A.3.9 (1/4). The "student's T" values show certain significance of the correlation, however the correlation coefficients themselves are not high enough for quantitative analysis. Estimated runoff for the latest 10 years is given in Table A.3.5(1/4).

Reliable flow during irrigation period (May to mid-March) is generally more than 10 m^3/sec. According to field observations during the study period, the discharge at the headworks was estimated at 20 m^3/sec. The Jalaur River basin is considered to be the best water source having a large catchment area and higher retaining capacity.

Water rights of 11.2 m^3/sec are allocated upstream of the Jalaur diversion headworks including 9.0 m^3/sec for the National Power Corporation (NPC), most of which can be used on the downstream as "return-flow". Water permits issued for downstream water users are negligible to the river discharge.

(b) Suague River

Runoff records at the Suague diversion headworks are shown in Table A.3.4 (2/4) and summarized below:

(unit: m^3/sec)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean	6.0	4.2	2.7	2.0	4.6	4.8	8.4	8.0	7.6	11.1	9.6	7.9
80% reliable	3.0	1.4	0.9	0.7	1.3	2.3	5.7	4.7	5.0	7.4	5.8	3.7

Source: NIA, DPWH Region VI office
Note: Period 1951 - 1971

No authorized runoff records being available since the year of 1972, rainfall-runoff correlation was examined in order to know runoff conditions in recent years. Taking into consideration the seasonal variation of runoff, correlations were examined by season as shown in Figure A.3.9 (2/4). The "student's T" values show certain significance of the correlation, however the correlation coefficients themselves are not high enough for quantitative analysis. Estimated runoff for the latest 10 years is given in Table A.3.5 (2/4).

According to field observations during the survey period, present river discharge upstream of the diversion headworks is 1.5 to 2.0 m^3/sec. Judging from rainfall condition of this period (more than the normal), it is estimated that the lowest flow during the dry season could become 0.5 to 0.7 m^3/sec. It is notable that paddy fields of about 1,000 ha on the upstream of the Suague headworks are receiving water from the Suague River. No water rights are given to the paddy fields. Hence the farmers there are regarded as "illegal" water users. Some of them harvest paddy rice three times a year by employing primitive irrigation practices.

According to simultaneous discharge measurements at four locations along the Suague River, the discharge at uppermost point with catchment area (CA) of 39 km^2 was 1.5 m^3/sec, 1.6 m^3/sec at the second uppermost point (CA=53 km^2), 1.8 m^3/sec at the third point (CA=87 km^2), and 2.0 m^3/sec just upstream of the diversion headworks (CA=181 km^2). No proportional increase in discharge to the catchment area was observed, which clearly indicates the influence of water extraction upstream of the Suague RIS.

(c) Tigum River

Runoff at the Santa Barbara diversion headworks is shown in Table A.3.4 (3/4) and summarized below:

unit: m^3/sec)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean	4.4	2.8	2.2	1.9	2.8	4.0	8.6	6.8	8.3	11.0	10.9	7.0
80% reliable	1.4	0.7	0.6	0.5	0.9	2.2	3.1	2.7	3.9	5.9	3.6	2.3

Source: NIA, DPWH Region VI office
Note: Period 1951 - 1971

No authorized runoff records being available since the year of 1972, rainfall-runoff correlation was examined in order to know runoff conditions in recent years. Taking into consideration the seasonal variation of runoff, correlations were examined by season as shown in Figure A.3.9 (3/4). The "student's T" values show certain significance of the correlation, however the correlation coefficients themselves are not high enough for quantitative analysis. Estimated runoff for the latest 10 years is given in Table A.3.5 (3/4).

It is shown in the above table that the reliable flow during the dry season is about 0.5 m^3/sec. However, based on the field observations, it is estimated that the low flow should give a higher value of about 1.0 m^3/sec.

(d) Aganan River

Runoff at the Aganan diversion headworks is shown in Table A.3.4 (4/4) and summarized below:

unit: m^3/sec)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean	0.98	0.22	0.37	0.59	0.77	1.60	3.56	2.96	2.33	3.98	2.04	1.27
80% reliable	0.04	0.02	0.03	0.03	0.06	0.28	0.78	0.60	0.63	0.56	0.21	0.13

Source: NIA, DPWH Region VI office
Note: Period 1951 - 1971

No authorized runoff records being available since the year of 1972, rainfall-runoff correlation was examined in order to know runoff conditions in recent years. Taking into consideration the seasonal variation of runoff, correlations were examined by season as shown in Figure A.3.9 (4/4). The "student's T" values show certain significance of the correlation for periods of October-January (beginning of dry season) and May-September (wet season), but no correlation is shown for February-April, the driest months of the year. Even for the two periods, the correlation coefficients themselves are not high enough for quantitative analysis. Estimated runoff for the latest 10 years is given in Table 3.5 (4/4).

It is shown in the above table that reliable flow during the dry season is less than 0.1 m^3/sec. However, based on field observations and related information, low flow is estimated at 0.8 to 1.0 m^3/sec in January, and that at 0.4 to 0.6 m^3/sec for February to April.

Few water rights are allocated along the Aganan River due to deterioration of the watershed. Low flow during the dry season is experienced, which hampers two croppings of paddy rice in the service area. Even during the wet season, river discharge at the Aganan headworks is mostly less than the designed discharge of the main canal.

Upstream water users resorted to diversification of crops such as maize, tomato, garlic, etc. due to water shortage.

(3) Water right

Water right is allocated by National Water Resources Board (NWRB) for which NIA represents in each region. The water right is allocated either surface water or groundwater according to its availability. It is considered difficult to allocate new water rights for irrigation for the above-mentioned water sources without new development, improvement or management of water resources. Water rights allocation for the four river systems is given in Table A.3.6 and summarized in Figure A.3.10.

Metro Iloilo Water District (MIWD) has acquired a water right of 350 liter/sec (290 liter/sec in dry season) while projected water production for 1997 is estimated at 8,306,730 m^3 or 263 liter/sec as shown below.

	Dam/sedi-mentation Basin	Infiltration Gallery 1	Infiltration Gallery 2	San Jose DTW No.8,9,10	Oton DTW No.1,2,3,5,7	STA Monica DTW, No.11	Total
Volume per day	5,472	1,998	-	8,424/6,624	6,804	1,890	
Jan.	169,632	61,938	-	205,344	210,924		647,838
Feb.	153,216	55,944	-	185,472	190,512		585,144
Mar.	169,632	61,938	-	205,344	210924		647,838
Apr.	164,160	59,940	-	198,720	204,120		626,940
May	169,632	61,938		205,344	210,924		647,838
Jun.	164,160	59,940	-	198,720	204,120		626,940
Jul.	169,632	61,938	-	261,144	210,924	58,590	762,228
Aug.	169,632	61,938	-	261,144	210,924	58,590	762,228
Sep.	164,160	59,940	-	252,720	204,120	56,700	737,640
Oct.	169,632	61,938	-	261,144	210,924	58,590	762,228
Nov.	164,160	59,940	-	252,720	204,120	56,700	737,640
Dec.	169,632	61,938	-	261,144	210,924	58,500	762,228
Total	1,997,280	729,270	-	2,748,960	2,483,460	347,760	8,306,730
Av. Op. hrs	23.75 hrs/day	15.00 hrs/day	20.00 hrs/day	21.00 hrs/day	21.00 hrs/day	21.00 hrs/day	
Av. Mon. Prod.	166,440 m^3	60,772.5 m^3	229,080 m^3	206,955 m^3	577,960 m^3	692,227 m^3	

Source: MIWD, Iloilo

Remarks: Av.Op.hrs: average operation hours, Av.Mon.Prod.: average monthly production

Note: For the first and second quarter of the year, production of San Jose production wells are based on 6,624 m^3/day excluding additional well which will be operational on the third quarter.

Present capacity of water supply system from the diversion weir at Daja is far below (62 liter/sec) the allocated water right due to poor conditions of existing facilities. MIWD compensates water shortage by deep tubewells in San Jose or Oton, and infiltration galleries along the Tigum River. MIWD is starting improvement works consisting of rehabilitation of diversion weir at Daja, expansion of pipeline capacity, construction of treatment plant, etc. The water supply system of MIWD is shown in Figure A.3.11.

(4) Water quality

According to the Department of Environment and Natural Resources (DENR) Order No.34, surface fresh water quality for different purposes is classified as follows:

Class AA: Public Water Supply Class I. This class is intended primarily for waters having watersheds which are uninhabited and otherwise protected and which require only approved disinfection in order to meet the National Standards for Drinking Water (NSDW) of the Philippines.

Class A: Public Water Supply Class II. For sources of water supply that will require complete treatment (coagulation, sedimentation, filtration and disinfection) in order to meet the NSDW).

Class B: Recreational Water Class I. For primary contact recreation such as bathing, swimming, skin diving, etc. (particularly those designated for tourism purposes).

Class C:
1) Fishery Water for the propagation and growth of fish and other aquatic resources;
2) Recreational Water Class II (Boating etc.)
3) Industrial Water Supply Class I (For manufacturing processes after treatment).

Class D:
1) For agriculture, irrigation, livestock watering etc.
2) Industrial Water Supply Class II (e.g. cooling etc.)
3) Other inland waters, by their quality, belong to this classification

Water quality criteria for conventional and other pollutants contributing to aesthetics and oxygen demand for fresh waters are also mentioned on Class D as follows:

Temperature rise:	3 °C over the average ambient temperature for each month.
pH (range):	6.0 - 9.0
Minimum DO:	40 % satn or 3.0 mg/l
5-day 20°C BOD:	10 (15)
TSS:	No more than 60 mg/l increase
TDS:	1,000 (if natural background is higher in concentration, this value is not applied.
Oil/Grease:	5.0 mg/l
SAR:	8.0 - 18.0
Boron:	No more than 0.75 mg/l

The monitoring point of water quality, conducted by DENR are presented in Figure A.3.12. According to the results, BOD exceeds the Class D criteria (15 mg/l) at several locations on the downstream of sugarcane factories during dry season.

(5) Sediment

Sedimentation is mainly caused by sand, gravel and soil particles carried through the river channel by river flow. Nature of sedimentation depends on such fundamental factors as meteorology, topography and geology of the area, scale, frequency and duration of flood, and grading of sand and gravel.

Sedimentation in proposed reservoirs was estimated in the study of the Jalaur Multipurpose Project. Sediment samples were collected at three (3) locations; namely, the Jalaur River at Alibunan, Passi, and Pototan. From those data, sediment rating curves were developed. Flow duration curves were also derived for corresponding stations. Thus annual sediment flow was estimated as follows:

Jalaur River Stations	Drainage Area (km^2)	Annual Sediment (MCM)	Yield Rate ($mm/km^2/year$)
Alibunan	120	0.18	1.5
Passi	534	0.72	1.5
Pototan	1,499	1.01	0.7

No other observed data being available on the sediment transport, the study team conducted sampling and laboratory analysis for the river bed materials in the vicinity of the proposed small reservoir sites and canal bed materials at the main canals of Suague, Sta. Barbara and Aganan RIS. These data have also been used as supporting information.

The following table gives an index for the estimation of specific sediment rate for dams with catchment area of less than 100 km^2 ($m^3/km^2/year$).

Topography	Geology	Catchment Area (km^2) 2	5	10	20	30	50	100
Young	A zone	-	-	100-300		300-800		800-1,200
	B zone	-	-	100-200		200-500		500-1,000
	C zone	-	-	100-150		150-400		400-800
Mature	A zone	-	100-200			200-400		500-1,000
	B zone	-	100-150			150-400		400-1,000
	C zone	-	50-100			100-350		300-500
Old	B zone	<50	50-100			100-350		300-500
	C zone		<50		50-100		100-200	
Peneplain	B zone		<50		50-100		100-200	
	C zone		<50		50-100			100-200

Source: Engineering Manual for Irrigation and Drainage "Fill Dam", JIID, 1988

Note (1) Topographic features;

(a) Young: heaviest erosion, lateral erosion encountered. River gradient of 1/100~1/500. Elevation differential of more than 500 m. River side slope of 30 degree or more.

(b) Mature; heavy erosion, piercing erosion encountered. River gradient of 1/500~1/700. Elevation differential about 400 m

(c) Old; slight erosion encountered, except during flooding. River gradient about 1/800. Elevation differential about 300 m

(d) Peneplain; slight erosion encountered, even during flooding. River gradient about 1/1000. Elevation differential about 100 m

Note (2) Geographic Conditions;

(a) A zone; Volcanic piedmont, more than 1/3 of the area is covered by landslide zone and special pyroclastic material zone.

(b) B zone; 1/5 to 1/3 of river basin is occupied by A zone

(c) C zone; other than A and B zones

Note (3) Area Conditions;

(a) Volcanic piedmont is of late Quaternary period (alluvium)

(b) Landslide zone is regarded as an area of marked occurrence of massive landslide or area having possibility.

(c) Special pyroclastic material zone is regarded as an area covered with Quaternary caldera pyroclastic material.

Conditions of the proposed small impounding reservoirs are considered to be classified in the topography type of "Young", the geographic type of "A zone" or "B zone", of which maximum specific sediment rate is 1,200 m^3/km^2/year or 1.2 mm/km^2/year.

Taking into consideration the proximity of catchment conditions and safety factor, the yield rate of 1.5 mm/km^2/year was assumed to be the specific sediment rate at the proposed small impounding dam sites.

(6) Development constraints

The most serious constraint on water resources for the national irrigation systems is low water availability for the command areas. It is considered that the basic concept or policy of the design and planning of the systems was to cover as much cultivated area as possible to optimize potential of agricultural production even with low irrigation reliability and/or less economic viability.

According to the socio-economic survey conducted during the study period, farmers' households which are suffering from water shortage even during wet season account for 20 % in Aganan RIS, 13 % in Sta Barbara RIS, 11 % in Suague RIS, 13 % in Jalaur proper RIS and 12 % in Jalaur extension RIS, respectively, while during dry season, 77% in Aganan RIS, 80 % in Sta. Barbara RIS, 83 % in Suague RIS, 77 % in Jalaur proper RIS and 75 % in Jalaur extension RIS. These figures may explain actual condition of water shortage even in the irrigated command area.

Regarding water resource development, high sediment transport rate in the source rivers hampers new development, particularly small impounding reservoirs.

Existing major problems and constraints on water resources development are summarized below by river system.

(a) Jalaur/Ulian River

- ∑ high sedimentation rate due to erosion of river banks
- ∑ high flood due to its large catchment area
- ∑ complicated water use with/without water rights along the river

(b) Suague River

- ∑ upstream water users without water rights

(c) Tigum River

- ∑ allocation of water to MIWD
- ∑ urbanization in the service area (lower development needs)

(d) Aganan River

- ∑ deterioration of watershed
- ∑ high floods
- ∑ high sedimentation rate

3.4.5 Geology

Outline of topography and geology at Panay island is shown in Figure A.3.13 and its stratigraphy is summarized in Table A.3.7.

The island has a regular triangle shape with a side of approximately 150 km; and in its east side, the eastern mountains with an altitude of about 500 m and in its west side, the western mountains with high peaks of more than 2,000 m, running north to south. Between the western and eastern mountainous lands, a lowland extends from Roxas in the northern coast to Iloilo in the southern coast, and over the southern part of the lowland is occupied by an alluvial Iloilo plain.

The eastern mountains consist mainly of Oligocene volcanics intruded by quartz diorite of probable Miocene age. The western mountains consist chiefly of Oligocene volcanic formation together with older ultrabasic rocks and metamorphic rocks. The oldest rocks in Panay island are metamorphic rocks exposed in the northwestern end of the island. Between the western and eastern mountain ranges, Iloilo sedimentary basin has been developed in a north to south trend since the Late Oligocene, and filled up by thick marine deposits. This sedimentary basin opens towards the sea in the northern and southern parts, and extends east and west from the border between the central lowland and the eastern mountains to the eastern slope of the western mountains.

The outline of the geologic formation can be summarized as follows:

Basement and Bayuso volcanics : In the Oligocene intermediate to mafic, volcanic activity took place over the whole area of Panay island.

Singit Formation : From the Early Miocene to the early half of the Late Miocene, the eastern half of the basin maintained a shelf environment with a little subsidence and reefal limestones were accumulated remarkably.

Dingle - Passi Formation : During the same period in the western half of the basin, a shallow sea environment appeared for short time at first followed by the accumulation of reefal limestone; and after that a rapid subsidence continued, resulting in the sedimentation of thick turbidite sequences. Through this period, the western mountains were being upheaved, and the sedimentation center represented by the thickest part of sediments was gradually shifting to the east.

Tarao Formation and Ulian Formation : Through the latter half of the Late Miocene to the Pliocene, the western half of the basin became gradually shallow sea , while the eastern half became a deep sea to some extent.

Iday Formation and Cabatuan Formation : In the Early Pleistocene, the western part of the basin emerged, while in the eastern half a shallow sea remained.

3.4.6 Geohydrology

(1) General

A geohydrological investigation was conducted to evaluate the recharge storage and the development potential of groundwater in the Aganan RIS area. In parallel with the investigation, the information, data, and reports relevant to the geohydrology and the groundwater in the Iloilo basin were collected from LWUR, JICA, MIWD, DPWH, and DENR.

The following works were executed in the geohydrological investigation:

- Drilling of a test well with 300 mm in diameter and 100 m in depth,
- Pumping test, and
- Water level observation of existing wells at 25 places including the said test well.

(2) Inventory survey of existing well

The existing wells surveyed are listed in Table A.3.8 and their locations are shown in Figure A.3.14. Considering such items as well type, pump type and well user, the existing wells were classified as follows:

well type	pump	submersible pump	suction hand pump	pail	flowing
tube	WS:7 FC:2,OF:4	FC:1,OF:1	-	-	-
artesian	-	FC:3 OF:1,IR:13	PB:37,HH:1	-	PB:15
open	-	OF:9 PB:7,HH:5	OF:2 PB:15,HH:4	PB:7 IR:2,HH:9	-

Note: Figure shows a number of well.
Well users WS : Water Supply (Metro Iloilo Water District)
FC : Factory (Pepsi,Coca Cola etc.)
OF : Office (Local office, Apartment, University etc.)
PB : Public use (Barangay hall, Elementary school etc.)
IR : Irrigation (Paddy field or water melon)
HH : Household (Private use)

Deep tube wells with 0.15 to 0.45 m in diameter and 30 to 120m in depth are dug by cable tool method and installed with iron pipe and long screens. They are pumped up by submersible or suction pump at a large discharge rate. These type wells are distributed only in narrow mid-plain area for public water supply, large factories or offices.

Shallow artesian wells with 0.05 to 0.15 m in diameter and 10 to 30 m in depth are dug by hand auger or simple driving machine. DPWH has made several hundred wells at barangay halls or elementary schools from 1950, but about half of them are not functioning due to the damage of hand-pump. Based on the report of JICA (1982, Basic Survey Report of Kyousui-sei-gas Development Project in Iloilo city, Panay Island, Philippines), it is supposed that many flowing wells remained all over the Iloilo basin before the completion of MIWD's deep wells. In the present survey, these flowing wells are found only at Sta. Barbara and Oton. Some personal wells with 10 to 30 m deep are dug by hand auger method for irrigation to paddy field. They are installed with engine pump. Some factories have the same wells installed with electric suction pump.

Shallow open wells with 0.6 to 1.2 m in diameter and 3 to 8 m in depth are dug by hand with shovel and lined by brick, rock, or concrete. These wells are used for domestic water supply by households, offices, factories, schools, etc. Many private wells are dug for irrigation to grow watermelon in paddy field at dry season. These wells are not lined anyway and pumped only by hand.

(3) Long term change of water level

From the pumping test records of deep tube wells under MIDP collected in the survey period, the long term change of water level and pumping discharge are derived as shown in Table A.3.9 and Figure A.3.15. From the same table and figure, the following are clarified:

- The static water levels are periodically lowering from GL-5 to -8 m at initial stage to GL-35 to -50 m at present stage for the last 10 years,
- The dynamic water levels are recovered soon at coming a stop of pump but their recovery ranges are very limited, and
- The dynamic water levels are lowered to GL-35 to -50 m immediately after starting in pumping up.

MIWD endeavors to maintain the dynamic water level of each well at GL - 50 m by some discharge rate; however, it could not sustain its water level. The sign of land subsidence appears evident with the damage of basement concrete at pumping station or the frequent rehabilitation of well. This means the overpumping of groundwater and that the hydraulic condition are not suitable to develop groundwater more than this rate.

(4) Short term change of water level

Figure A.3.16 shows the short term changes of water levels of the deep tube well with 50 m deep at the Post-Harvest Facility and of the shallow wells in the surrounding area derived from the results of investigation by the study team. From the figure, it can be inferred that the water level change of the deep well does not affect the water levels of the shallow wells.

Figure A.3.17 shows the short term changes of water levels of the 100 m deep well (MIWD's No. 9) and of the shallow wells in the surrounding area, while Figure A.3.18 shows the water level changes of MIWD' No. 11 deep well under construction and of neighboring shallow wells. From these figures, it can be also said that the water level changes of the shallow wells have no relation to those of deep wells.

The change of shallow groundwater is closely related to the recharge by rainfall, canal water, irrigated water , etc.

(5) Water quality

Such water quality data as electric conductivity, pH and water temperature of existing wells measured in the investigation by the study team are shown in Table A.3.8. The data on main ions of existing wells are also shown in Table A.3.10 derined from the results analyzed in the Basic Survey Report of Kyousui- sei -gas Development Project, JICA in 1982. Based on these data, a contour map of electric conductivity and hexadiagram of water quality was prepared as shown in Figure A.3.19.

It is reported that saline water has strongly affected shallow wells in the Iloilo district. However all these wells have been mostly disposed. Because the existing wells, of which an effect of saline water can be investigated, were limited to the deep wells located at the center of the Iloilo plain and the shallow wells scattered over the plain, the area affected by saline water could not be clearly confirmed. As shown in Figure A.3.19, the area with high electric conductivity of more than 200μS/cm extends from Oton along the Iloilo river to Moro and Santa Barbara, while the area with low electric conductivity of less than 100 μS/cm are located in the center of the Iloilo plain.

According to the hexadiagram of water quality shown in Figure A.3.19, the groundwater in the center of Iloilo plain contains only bicarbonate as an ion, while the groundwater at Moro and Sta. Barbara contains a lot of chloride ions and total dissolved solids with more than ten (10) times of standard value. High contents of total dissolved solids are considered to be caused by natural gas recharged in the deep underground of Iloilo plain.

(6) Investigation by test well

A test well with 100 m deep was bored for fourteen (14) days from February 6 to 24, 1997 at the center of the Aganan RIS area considering the locations of existing deep tube wells. During the course of drilling, cave-in occurred at two places, 50 m and 70 m in depth, respectively. The respective iron pipes with 250 mm and 200 mm were inserted into the borehole for protection of weak stratum and the well was bored again through the pipes by the percussion bit. The final screen diameter was 150 mm and the groundwater was pumped up between 50 m and 70 m. As shown in Figure A.3.20, the stratum at the test well site consists of alternation of silt and sand layers containing too much clay. It is considered that the stratum with cave-in is aquifer. Using the test well, the following pumping tests were conducted (Figure A.3.21):

- step draw-down test with 5 steps for 10 hours, and
- continuous constant discharge test for 48 hours.

The critical pumping rate could not be determined because the stable pumping amount could not be measured through the step draw-down test. Through the continuous constant discharge test, the following were observed:

- within an hour after start of the constant discharge test with a rate of 2.15 l/sec, the pumped groundwater has changed to red-brown color water with gas indication, and
- the water amount has been reduced to 1.64 l/sec and the water level has been lowered to GL- 40 m.

The hydraulic coefficient was calculated using the data obtained for two (2) hours after starting the constant discharge test. The result is shown in the following table compared with the hydraulic coefficients of MIWD' deep well collected through the field survey.

WELL	SWL GL-m	DWL GL-m	Draw Down m	Duration hrs	Q l/sec	SC l/sec/m	T m^2/sec
Test Well	9.45	38.00	28.55	2	2.00	0.07	4.60*10-5
No.8	5.81	28.69	22.88	24	40.13	1.75	1.40*10-3
No.9	8.44	27.30	18.86	78	38.46	2.04	2.50*10-3
No.10	4.87	22.75	17.88	80	40.15	2.25	1.73*10-3

Note : SWL: Static Water Level
DWL : Dynamic Water Level
SC : Specific Capacity (Q/ Draw Down)
T : Transmissibility
k = T/b = 4.60*10-5/20 = 2.30*10-6 (m/sec) = 2.30*10-4 (cm/sec)

(7) Groundwater potential in Aganan RIS area

The geological structure of the Iloilo plain is shown in Figure A.3.22 derived from Basic Survey Report of Kyousui-sei-gas Development Project, JICA in 1982. The figure was made on the basis of the results of nine exploratory drilling, the seismic prospecting, the physical test of sediments and the geochemical survey.

The rain water and irrigation water in the Iloilo plain penetrate into the ground and form the shallow groundwater. Figure A.3.23 shows the contour map of the static water levels of existing wells indicating the depth of water level from the ground surface. As shown in the figure, the shallow groundwater level is only 1 m to 4 m, while the deep groundwater level is at GL-40 m due to water use for a long time. Even at the location of MIWD 's deep well No. 11 where the development has not been proceeded, the groundwater level is at GL-16 m. Considering the change of groundwater level and water quality investigated in the field survey, movement of groundwater between the shallow well and the deep well is considered small.

From the geological structure in the Iloilo plain, it is said that the sandstone layer is the thickest at the center of the plain. This stratum forms the hilly area in the northern part of the plain and gradually inclines towards the south-east direction. In the river beds of Aganan and Suague River, the alternation of sandstone and mudstone layers is exposed. It is considered that a fairly large amount of river water infiltrates and forms deep groundwater here.

As stated above, although a relatively large amount of deep groundwater exists at the center of the Iloilo plain, its development has already exceeded the sustainable level. It would be very difficult to develop the deep groundwater in the other area because of its low potential as investigated by the test well in the field survey. On the other hand, it would be possible to develop the shallow groundwater up to 30 m deep with limitation on location and amount considering the following:

- shallow groundwater would be recharged by rain and irrigation water,
- its water level is kept high even in the dry season, and
- no effect on water level of shallow well by pumping a large amount of water up from the neighboring deep well.

3.4.7 Soils

(1) Soil classification

There are two (2) types of soils of different landforms found in the study area such as the alluvial soils of the lowland and the residual soils of the upland. The potential irrigable areas have maximum slopes of 8 %; class A, 0 - 3% and class B, 3 - 8 % slope. Three (3) soil series with a total of six (6) soil mapping units are identified and established which are important to consider in terms of soil fertility and soil management practices in the irrigable lands.

The alluvial lowland is divided into four (4) soil mapping units. Except the unit with fine soil material in the recent flood plain, all the other three (3) soil mapping units of the alluvial lowland are potential for paddy irrigation having fine-clayey and deep profile feature. On the other hand, only two (2) soil mapping units are recognized in residual upland which are generally found from Barotac Nuevo municipality extending northwest towards Dingle municipality, and cultivated to sugarcane. The residual upland soils are also very deep, fine clayey and have fairly good surface drainage with materials originating from limestone and basic sedimentary associated with its formation.

Soil classification map is illustrated in Figure A.3.24. As mentioned above, the soil series, soil mapping units, and characteristics are summarized below.

Land forms Physiographic Unit	Soil Series (Symbol)	Drainage	Slope (%)	Parent Material	Soil Taxonomy	Area (%)
Alluvial Lowland						
Level to very gently sloping	Sta. Rita (10A)	Poorly drained	0 - 3	Silt & clayey alluvium	Fine clayey, Montmorillionitic Isohypherthermic, Typic Epiaquerts	67.2
do	Sta. Rita (10Af3)	Very poorly drained	0 - 3	do	Fine clayey, Montmorillionitic Isohypherthermic, Typic Epiaquerts	2.3
Slightly elevated and terrace, gently sloping to undulating	Sta. Rita (10B)	poorly drained	3 - 8	do	Fine clayey, Montmorillionitic Isohypherthermic, Typic Epiaquerts	2.7
Level to very gentle sloping, recent flood plain	Umingan (20Af1)	Well drained	0 - 3	Recent river sediments	Fine loamy, Mixed Isohyperthermic Fluventic Eutropepts	1.3
Residual Upland						
Level to very gently sloping plain	Faraon (30A)	Well drained	0 - 3	Limestone residium	Fine clayey, Montmorillionitic Isohypherthermic, Typic Hapludalfs	12.6
Gently sloping to undulating	Faraon (30B1)	Well drained	3 - 8	do	Fine clayey, Montmorillionitic Isohypherthermic, Typic Hapludalfs	0.3
Miscellaneous Land Type (Residential, Hills, River/creeks)						13.6

Santa Rita soil series is a member of the very fine-clayey family, montmorillionitic, isohyperthermic Typic Epiaquerts. The soils occur in the broad alluvial plain, poorly drained, that developed from recent alluvial deposits consisting of fine soil materials from the surrounding uplands. It has slopes ranging from flat to very gently sloping. The soils exhibit cracks that are wide and deep at least in the dry season, and close when wet. The soils have very dark surface when wet. The surface soils are fine clay, but very coarse and hard when dry. The soil fertility is moderate to high.

Umingan soil series is a member of the fine-loamy family, mixed, isohyperthermic Fluventic Eutropepts. These are well drained soils found along the recent flood plain of Jalaur river which are seasonally subjected to moderate river flooding. The soils are moderately deep, which developed from river sedimentation. The surface soils are silt loam in texture. The soil fertility is moderately high.

Faraon soil series is a member of the fine-clayey family, montmorillionitic, isohyperthermic Typic Hapludalfs. These soils are very deep and well drained, found in the northeast of the study area with gentle to undulating slopes. The soils are developed from old marine and limestone sediments. The surface soils have textures ranging from medium clay to heavy clay.

Mapping unit 10A of Sta. Rita soil series is a dominant soil in the study area covering 67 % of the study area. The extent of each soil series and mapping unit by RIS and potential extension area is shown in Table A.3.11, and summarized below.

(Unit: ha)

Soil Series	Sta. Rita			Umingan	Faraon		Miscellaneous	
Mapping Unit	10A	10Af3	10B	20Af1	30A	30B1	land	Total
Existing RIS								
Jalaur Proper	10,770	990	-	90	140	-	940	12,930
Jalaur Extension	1,520	-	-	460	2,570	50	1,070	5,670
Suague	3,430	-	160	-	-	-	690	4,280
Aganan	5,030	-	-	-	-	-	1,490	6,520
Sta. Barbara	3,410	-	-	-	-	-	1,410	4,820
Potential Extension Area								
1.Pototan	490	-	-	-	-	-	10	500
2.New Lucena	400	-	-	-	-	-	10	410
3.Sta. Barbara	-	-	990	-	-	-	40	1,030
4.San Miguel	2,470	-	-	-	-	-	40	2,510
5.Oton	1,350	-	-	-	-	-	80	1,430
6.Barotac Nuevo	-	-	-	-	2,720	70	40	2,830

(2) Physical and chemical properties of soils

The laboratory tests for physical and chemical properties were carried out on 150 soil samples. The results of laboratory test are shown in Table A.3.12. The major properties are as follows:

	Unit	Average	Maximum	Minimum	Assessment
Soil texture		(major texture Clay to Silty Clay)			suitable for paddy rice
Clay particle	%	57	83	18	suitable for paddy rice
Organic Carbon	%	1.1	1.9	0.1	moderate
Total Nitrogen	%	0.09	0.17	0.01	moderate
pH	6.6	6.6	7.2	5.3	neutral to slightly acid
EC	mS/cm	0.2	1.04	0.01	no sodic, salinity
Available Phosphate	mg/100g	12.3	81.2	0.5	moderate
CEC	meq/100g	44	66	8	high (good)
Exchangeable Ca	meq/100g	21	47	3	high (good)
Exchangeable Mg	meq/100g	13	30	2	high (good)
Exchangeable Na	meq/100g	0.5	1.6	0.2	moderate (good)
Exchangeable K	meq/100g	0.5	2.5	0.1	moderate
Base Saturation	%	80	110	62	moderate to high

(3) Land suitability

Land suitability of the study area has been assessed using the FAO Framework for Land Evaluation (1976). It is a system of grouping soil units together having similar characteristics, degree of limitations and management requirement. The soil characteristics and land qualities considered in the assessment of suitability classes and sub-classes include slope, erosion hazard, texture, effective soil depth, drainage condition, flooding, presence of coarse fragment, rock or outcrops, soil pH, total nitrogen, available phosphorus and cation exchange capacity.

Wetland rice and diversified crops were assessed based on their performance in each soil mapping unit considering their soil requirements and soil characteristics. Table A.3.13 presents the soil criteria and class limits used to evaluate soil mapping units for each land utilization types.

Suitability order indicates whether or not the land is suitable for the use consideration. Suitability classes reflect the degrees of suitability of soil unit within the order as shown below:

Suitability	Description
Order Suitable (S) :	Soils on which sustained use of the kind under consideration is expected to yield benefits which justify the inputs without risk or damage of land resources.
Highly Suitable (S1) :	Soils having no significant limitation to sustained application of a given use.
Moderately Suitable (S2) :	Soils having limitation which together are moderately severe for sustained application of a given use; production will be significantly lower and/or inputs significantly higher than S1 land.
Marginally Suitable (S3) :	Soils with limitations that, in total, are severe for sustained application of a given use, production will be so reduced and/or the needed inputs will be so high that the use of this land will only be marginally justified.
Order Not suitable (N) :	Soils which have the qualities that appear to preclude sustained use of the kind under consideration. The value of expected benefits do not justify the expected cost of inputs that would be required.

The soil mapping units were divided into four (4) suitability groups by land utilization types and management requirements. The groupings and land suitability classes for each land use are shown as follows:

Suitability Group	Soil Mapping Unit	Land Class		Area (%)
		Wetland Rice	Diversified Crops	
A:	30A and 30B1	S1	S1	12.9
B:	20Af1	S3s	S1	1.3
C:	10A and 10B	S1	S3d	69.9
D:	10Af3	S2f	N	2.3
(Miscellaneous Land)				13.6

Limitation : s - texture, t - slope, d - drainage, f - flooding
Suitability class : S1 - Highly suitable, S2 - Moderately suitable
S3 - Marginally suitable, N - Not suitable

Suitability group A is formed on flat to very gently to undulating slope. It is characterized by fine textured soils with good drainability. The land is classified suitable for all land use types: wetland paddy rice and diversified crops.

Suitability group B has a moderately deep rooting zone with loamy surface soil that is well drained and with coarse textured substratum. It is found on a flat to very gently sloping land, ranging from 0 - 3 % slopes, subject to slight seasonal river flooding. This soil group has a limitation of being loamy surface textured. The land is classified as marginally suitable for wetland rice (S3s) and highly suitable (S1) for diversified crops.

The lands under group C are classified as highly suitable for wetland paddy rice and marginally suitable for diversified crops due to poor drainability.

Group D occupies the slightly depressed area in the broad alluvial lowland which is subject to severe run-off flooding. The soil characteristics are similar to group C except that it has limitation on flooding which would limit its suitability to wetland rice production.

Land suitability map is illustrated in Figure A.3.25. Generally, Jalaur extension RIS and the potential extension areas in Barotac Nuevo are highly suitable for wetland rice and diversified crops. Other study areas are highly suitable for wetland rice, and marginally suitable for diversified crops because of poor drainability. The extent of land suitability of the RISs and extension areas is shown in Table A.3.14, and summarized below.

(Unit: ha)

Land Use Type	For Wet Land Rice				For Diversified Crops				Miscellaneous	
Suitability Class	S1	S2f	S3s	N	S1	S2f	S3d	N	Land	Total
Existing RIS										
Jalaur Proper	10,910	990	90	-	230	-	10,770	990	940	12,930
Jalaur Extension	4,140	-	460	-	3,080	-	1,520	-	1,070	5,670
Suague	3,590	-	-	-	-	-	3,590	-	690	4,280
Aganan	5,030	-	-	-	-	-	5,030	-	1,490	6,520
Sta. Barbara	3,410	-	-	-	-	-	3,410	-	1,410	4,820
Potential Extension Area										
1. Pototan	490	-	-	-	-	-	490	-	10	500
2. New Lucena	400	-	-	-	-	-	400	-	10	410
3. Sta. Barbara	990	-	-	-	-	-	990	-	40	1,030
4. San Miguel	2,470	-	-	-	-	-	2,470	-	40	2,510
5. Oton	1,350	-	-	-	-	-	1,350	-	80	1,430
6. Barotac Nuevo	2,790	-	-	-	2,790	-	0	-	40	2,830

3.5 Rural Infrastructure

Rural infrastructure such as road networks, potable water supply, village electrification, public health care, communication facilities. etc. are generally maintained well in the study area by local governments. However, major constraints of rural infrastructure are found in the current road networks especially farm - to - market road and potable water supply.

Present conditions of major rural infrastructure such as road networks, potable water supply and electrification are explained as follows:

3.5.1 Road Networks

Rural road network in the study area consists of national, provincial, municipal and barangay roads. Furthermore, the NIA service roads are being considered as part of the rural road network. Except for the NIA service road and some barangay roads, majority of the national, provincial and municipal roads are paved by concrete and / or asphalt, and maintained well.

The road networks in the 5 river irrigation systems (RIS) are summarized as follows:

	Road Networks (km)				
Municipality	National	Provincial	Municipal	Barangay	NIA
Jalaur RIS area	93.7	114.4	69.1	174.6	238.6
4 municipalities (Dumangas, Zarraga,Barotac Nuevo & Dingle)					
Suague RIS area	57.8	36.6	11.5	175.3	35.4
3 municipalities (Mina, New Lucena & Pototan)					
Sta. Barbara RIS area	19.9	48.1	16.5	101.3	35.2
3municipalities (Leganes, Pavia & Santa Barbara)					
Aganan RIS area	42.3	39.1	15.4	46.6	39.0
2 municipalities (Oton & San Miguel)					
Total	213.7	238.2	112.5	497.8	348.2

Majority of the rural roads are annually maintained to sustain passable condition, and there are no remote areas even during the rainy season. The salient features of road networks in the study area are shown in Table A.3.15.

The one of the biggest constraint to the rural road development is non establishment of link road system in the municipal area due to lack of bridge and the lack of the farm to market road. The lack of the link road system affects much the rural economy, the public services to the inhabitants, agriculture activities in the RIS areas such as transportation of agriculture input and output, post-harvest activities and market activities.. The main reason of the lack of the bridge and the farm to market road is the LGU's financial shortage. The detailed constraint is shown in Table A.3.16.

Some LGUs have an intention to provide additional farm - to - market road to strengthen the rural economy development, utilizing the NIA service road. However, the majority of NIA services roads are not maintained well and the road system can not be linked smoothly.

3.5.2 Water Supply

Potable water supply development is implemented in the study area by the local governments, DPWH and LWUA. The potable water supply comprises Level I, II and III water systems. The status of the potable water supply in the study area is that Level I water supply system is generally extended widely with an extension ratio of more than 50 % . Some municipalities which have water districts such as Dumangas, Dingle and Pavia have a little extension of the Level III water supply system.

The Metro Iloilo Water District (MIWD), which provides potable water to Iloilo city, has its source in the upper stream of the Tigum river from Maasin municipality and the deep ground water in the Aganan RIS area. The rehabilitation of existing pipeline and the extension of the beneficiary area are currently being undertaken by the MIWD and LWUA. Furthermore, LWUA started a study on the rural potable water supply development in the Aganan and Tigum river basins to sustain sufficient potable water supply to Iloilo city under the technical assistance of the Swedish International Development Administration (SIDA).

MMunicipality	Total House-hold	Level1		Level 2		Level 3		Doubtful Sources	
		Household	%	Household	%	Household	%	Household	%
Jalaur RIS area	26,684	11,915	45	79	0	4,629	17	10,061	38
4 m unicipalities (Dumangas, Zarraga, Barotac Nuevo & Dingle)									
Suague RIS area	15,812	11,757	74	0	0	1,111	7	2,944	19
3 municipalities (Mina, New Lucena & Pototan)									
Sta. Barbara RIS area	14,539	8,621	59	212	1	2,074	14	3,632	25
3 municipalities (Leganes, Pavia & Santa Barbara)									
Aganan RIS area	11,357	4,573	40	110	1	16	0	6,658	59
2 municipalities (Oton & San Mguel)									
Total	68,392	36,866	54	401	1	7,830	11	23,295	34

Table A.3.17 shows the status of potable water supply in the municipalities concerned with the study area in 1993.

Constraint to potable water supply in the study area is the LGUs' financial shortage of the up-grading the distribution system in the barangay areas from the level I to the level II or from the level II to the level III. The LGUs who need the urgent water supply development have already made the plan under the consultation with DPWH and LWUA. The detailed constraint is shown in Table A.3.16.

3.5.3 Electric Power Supply

Electric power supply system is sustained in and around the study area by two (2) electric cooperatives, namely Iloilo I Electric Cooperative Incorporated (ILECO I) and Iloilo II Electric Cooperative Incorporated (ILECO II). The energized lateral line networks are expanded in the 22 municipality areas concerned with the study area and each river basin, excluding Iloilo city area.

Electric Cooperative	Municipality	
	RIS areas	Upstream area from RIS areas
ILECO-I	Sta. Barbara, San Miguel, Leganes, Pavia, Oton	Cabatuan, Maasin, Alimodian,
ILECO-II	Dingle, Mina, Pototan, New Lucena, Zarraga, Barotac Nuevo, Dumangas	Passi, San Enrique, Duenas, Calinog, Lambunao, Badiangan, Janiuay

The status of electric power supply in the study area is that regional power supply capacity is sufficient, and village electrification will be able to expand, subject to the LGU's financial capacity and that the 2 RIS areas near the Iloilo city such as Sta. Barbara and Aganan RIS areas have more village electrification than the other RIS areas as shown below.

Municipality	Beneficiary (Household)		
	Potential Customer	House Connection	%
ILECO I			
Sta. Barbara RIS area	13,341	9,004	67
3 municiplities (Leganes, Pavia & Santa Barbara)			
Aganan RIS area	11,622	8,300	71
2 municipalities (Oton & San Mguel)			
IELCO II			
Jalaur RIS area	28,463	9,927	35
4 municipalities (Dumangas, Zarraga, Barotac Nuevo & Dingle)			
Suague RIS area	12,801	5,161	40
3 municipalities (Mina, New Lucena & Pototan)			
Total	66,227	32,392	49

The electric cooperatives have also prepared the long term implementation program of village electrification by the year 2010.

3.6 Agriculture

3.6.1 Land Use

The major use of agricultural land in the relevant 13 municipalities and Iloilo city is paddy rice field. It indicates that the study area is one of the largest paddy rice producers in the Philippines. Sugarcane field covers the northeastern part of the study area covering the municipalities of Anilao, Dingle, Barotac Nuevo, Pototan and Dumangas. Other crops, consisting mainly of tree crops such as mango and coconut, are planted on natural levees along the rivers and the surroundings of residential areas in the villages. Fish ponds and salt-pan beds are located along the coastal zone of Iloilo Strait. Fish pond owners are raising milkfish and shrimp.

The land use in the study area is principally classified into two categories: agricultural land and non-agricultural land. The agricultural land is sub-divided into paddy land, sugarcane land, pasture land, and other areas planted to tree crops such as mango and coconut. The non-agricultural land is also sub-divided into built-up land (residential, commercial and industrial lands), and other lands occupied by open forest lands (wood/bamboo land of hill/hillock and along river/creak) and rivers/creeks.

The present land use of the study area is shown in Table A.3.18 by RIS and extension area. The figures were derived from the present land use map (Figure A.3.26) by field survey and interpretation of aerial photographs.

Recent survey indicates that the commercial and residential zones of Iloilo City and neighboring towns are rapidly encroaching into agricultural land. A part of service area of Aganan and Sta. Barbara RISs has already been encroached by land developers for residential or commercial use due to urbanization. According to the land use survey, 500 ha of paddy field in Aganan RIS, and 400 ha in Sta. Barbara RIS have been converted into urban land use including illegally converted lands. Especially in the irrigation division No. 6 of Aganan RIS and irrigation division No. 2 of Sta. Barbara RIS, about 50% of former service areas have been converted into subdivision. On the other hand, the local governments of Iloilo province, Iloilo city and neighboring municipalities are preparing a master plan for future land use for urban growth, considering the land use conversion from agricultural use to residential and industrial use. Under such condition, NIA Aganan-Sta. Barbara office has scheduled to review the service areas of both RISs in 1997. Such as rapid and large land conversion may cause low efficiency of the irrigation systems.

About 64 % of the total land in the existing RISs are occupied by paddy land. Land planted to sugarcane covers 440 ha and 850 ha in Jalaur proper RIS and Jalaur extension RIS respectively. In other RISs, sugarcane is not or rarely cultivated. Almost all sugarcane area cultivated is under the hacienda estate of large landowners.

(Unit: ha)

Name of RIS	Total Area	Paddy Field	Sugar-cane	Other Crops*	Non-agri. Land
Jalaur proper	12,930	8,820	440	40	2,650
Jalaur extension	5,670	2,620	850	80	1,830
Suague	4,280	2,960	50	0	940
Aganan	6,520	4.360	0	0	1,680
Sta. Barbara	4,820	3,000	0	0	1,490
Total	34,220	21,760	1,340	120	8,590

Note * : Major tree crops are mango and coconut

In the extension areas, about 69 % or 6,030 ha of the total land area of 8,710 ha are occupied by paddy field. Paddy field of the extension areas is mostly cultivated under rainfed condition, except the partially irrigated areas by pumps using shallow tube well or creek water. Sugarcane is cultivated widely in the extension area of Barotac Nuevo by estate farming, and is the dominant crop in the area. The extension area in Sta. Barbara is utilized for grazing or pasture. Change of land utilization from sugarcane or pasture to paddy field in the near future will not be definite considering progress of CARP as mentioned later.

(Unit: ha)

Name of Extension Area	Total Land	Paddy Field	Sugar-cane	Other Crops*	Non-agri. Lands
(1) Pototan	500	480	0	0	20
(2) New Lucena	410	390	0	0	20
(3) Sta. Barbara	1,030	800	0	160	70
(4) San Miguel	2,510	2,430	0	0	80
(5) Oton	1,430	1,250	0	0	180
(6) Barotac Nuevo	2,830	680	2,030	0	120
Total	8,710	6,030	2,030	160	490

Note * Mainly pasture for grazing

3.6.2 Land Tenure and Operating Farm Size

As mentioned in sub-section 3.10.4, the distributed area by CARP in the relevant 13 municipalities and Iloilo city is 6,355 ha or 25% against scope area of 25,258 ha in rice/corn lands and other agricultural lands as of December 31, 1996.

The socio-economic survey conducted by the study team indicates that tenant farmer is dominant in the study area: about 50 % of the irrigation beneficiaries are tenant farmers, and only 30% of them are owner cultivator as shown below.

	% of farms				Average cropping area (ha)				
RIS	OC	OT	TE	O	OC	OT	TE	O	Overall
Jalaur proper	30	18	51	1	2.43	4.94	2.34	1.50	2.83
Jalaur extension	28	26	46	-	1.50	4.11	2.22	-	2.22
Suague	35	27	38	-	2.56	5.00	1.99	-	3.01
Aganan	25	19	55	1	2.15	2.59	2.67	4.00	2.55
Sta. Barbara	30	18	52	-	1.53	4.58	2.56	-	2.62
Average	29	21	50	-	2.20	4.60	2.30	2.50	2.68

Note: OC-owner cultivator, OT-owner-cum-tenant, TE-tenant, O-others

The average operating farm size is ranging between 2.22 and 3.01 ha. The socio-economic survey also indicates that 33 % of respondents are cultivating with farm size ranging from 1.00 to 1.99 ha, and that 15 % of them are operating with paddy land of 5.0 ha and more.

RIS *	JP	JE	SU	AG	SB	Total
No. of total respondents	149	55	48	74	50	376
Ratio of respondents by cropping area (%)						
Under 0.5 ha	7	11	2	7	12	8
0.5 to 0.99 ha	10	15	8	8	8	10
1.00 to 1.99 ha	32	38	35	35	24	33
2.00 to 2.99 ha	16	15	13	16	24	16
3.00 to 4.99 ha	19	11	21	22	22	19
5.00 to 7.99 ha	12	9	17	12	8	12
8.00 to 9.99 ha	1	0	4	0	2	1
10.0 ha and more	3	2	0	0	0	2

Note * JP: Jalaur proper, JE: Jalaur extension, SU: Suague,
AG: Aganan, SB: Sta. Barbara

Crop sharing of leased-tenanted paddy land is generally using traditional system. By traditional system, produced paddy rice is divided into three parts, for harvest/threshing labor, for crop-share-tenant farmer, and for land owner paid all costs of farming operation: 1/8 or 1/7 of total production, 10 % of remaining 7/8 (or 6/7: usually said net yield), and 90 % of remaining 7/8 (or 6/7: net yield), respectively. By general sharing system of lease-holder who pays constant land fee to the land owner, recently, the lease-holder shoulders production cost and pays 12 to 22 sacks paddy rice (500 to 920 kg of moist paddy per ha), 15 sacks on the average (630 kg of moist paddy /ha).

3.6.3 Cropping Pattern and Farming Practices

(1) Cropping pattern

The cropping system in the study area indicates that paddy rice is dominantly cultivated, and farmers wish to increase their cropping intensity. Various cropping patterns are adopted in the study area. The cropping pattern is significantly dependent on the availability of irrigation water. The farmers in the irrigated area by RISs are applying the following cropping patterns:

(a) Paddy (wet season) - Paddy (dry season),

(b) Paddy (wet season) - Paddy (dry season) - Mungbean,
(c) Paddy (wet season) - Paddy (dry season) - Watermelon, and
(d) Paddy (wet season) - Paddy (dry season) - Paddy (third paddy).

Pattern (a) prepared by NIA for irrigation water distribution is a standard pattern. Pattern (b) is adopted widely by farmers in the area in order to avail additional production and to maintain soil fertility by planting legume crops. Mungbean is grown under rainfed condition using residual soil moisture after paddy harvest.

Pattern (c) is mainly adopted in Aganan and Sta. Barbara RISs. The watermelon is planted after harvesting of second paddy crops, and it is irrigated manually using dug well water in the paddy field. Other high value crops such as tomato, okra, squash, and stringbean are planted in small extent following the same pattern.

Pattern (d) is characterized by three (3) crops of paddy rice per annum which can be seen in the upstream areas in each RIS, where there is higher water availability than in the downstream areas. Farmers in the upstream areas move rice planting forward as soon as possible in order to plant third paddy. In general, third paddy rice is still growing after the stop of water distribution by RIS. The farmers provide irrigation water from shallow tube wells or creeks. This cropping pattern disarranges the standard cropping pattern prepared by NIA.

Hence, there are some areas with insufficient supply of irrigation water in the existing RISs. Farmers in these area cultivate paddy under rainfed condition or with supplementary irrigation using pumps from shallow tube wells and creeks.

(2) Cropped area

NIA reports every cropping season the irrigated/planted area (actually irrigated area), benefited area (the crop areas where paddy yields are 2,000 kg and more per ha per crop), and average unit yield against benefited area. The average irrigated and benefited areas in the last 5 years (1992 to 1996) by RIS are shown below.

	(a) Irrigated Area (ha)		(b) Benefited Area (ha)		(b)/(a) (%)	
	Dry	Wet	Dry	Wet	Dry	Wet
Jalaur proper	6,453	6,867	4,909	6,122	76.1	89.2
Jalaur extension	2,010	2,310	1,628	2,213	81.0	95.8
Suague	2,465	2,600	1,874	2,582	76.0	99.3
Aganan	1,186	4,585	876	4,551	73.9	99.3
Sta. Barbara	1,993	3,038	1,830	3,037	91.8	100.0
Total	14,107	19,400	11,117	18,505	78.8	95.4

Average of 5 years (1992 - 1996)
Source : NIA Aganan-Sta. Barbara and Jalaur-Suague offices

The above table indicates that 5 % and 21 % of irrigated area have not been benefited in the wet season and dry season respectively in the last 5 years. Since the unit yield of the non-benefited area is very low as mentioned above, it seems that the non-benefited area had not been able to irrigate effectively. Hence, it is assumed that effective irrigated area are proportionate to the benefited area. Table A.3.19 shows the benefited area in the last 5 years (1992 to 1996) by irrigation division and cropping season.

Based on the field investigation and interviews with MAOs, paddy rice is also planted under rainfed condition or by supplementary irrigation in the RISs' service area, where water is not supplied by RIS. Third paddy rice is also planted as mentioned in cropping pattern (d). These areas are estimated from the socio-economic survey, field investigation and statistics of paddy production.

Table A.3.20 shows the paddy production of Iloilo province. This production stastitics in Ililo province present remarkably that:

- Harvested area has not so changed at 200,000 ha level, however, irrigated area has increased between 1991 and 1996. It is supposed that the expansion of irrigated area depended mainly on generalization of private small-sized irrigation pumps among farmers.
- Average yield also has risen abruptly from 1991 to 1993, but in 1995 and 1996 it was stagnant or decreased.

	Average of 1987 - 1997	1992	1993	1994	1995	1996	Average of 1992 - 1991
Harvest Area (1000ha)							
Total	194	203	205	209	194	220	206
Irrigated	58	67	92	96	94	113	93
Average Yield (ton/ha)							
Irrigated	3.20	3.88	4.26	4.05	3.57	3.22	3.80
Rainfed	2.09	2.20	2.57	2.49	2.17	2.28	2.34
Production (1000ton)							
Total	472	560	683	669	553	609	615

The cropped areas of irrigated and rainfed paddy rice and their respective cropping intensity are shown below.

(Unit: ha)

	Wet Paddy		Dry Paddy		3rd Paddy	Total	Cropping Intensity (%)		
	Irrigated	Rainfed	Irrigated	Rainfed	Rainfed		Irr.	Rain.	Total
RIS									
Jalaur proper	6,120	2,600	4,910	1,940	1,200	16,770	125	65	190
Jalaur ext.	2,210	410	1,630	580	250	5,080	147	47	194
Suague	2,580	380	1,870	610	50	5,490	150	35	185
Aganan	4,050	300	1,230	900	200	6,680	121	32	153
Sta. Barbara	2,710	250	2,110	100	200	5,370	161	18	179
Subtotal	17,670	3,940	11,750	4,130	1,900	39,390	135	46	181
Extension Area									
Pototan	-	480	-	50	-	530	-	110	110
New Lucena	-	390	-	40	-	430	-	110	110
Sta. Barbara	-	800	-	80	-	880	-	110	110
San Miguel	-	2,430	-	240	-	2,670	-	110	110
Oton	-	1,250	-	120	-	1,370	-	110	110
Barotac Nuevo	-	680	-	70	-	750	-	110	110
Subtotal	0	6,030	0	600	0	6,630	0	110	110
Total	17,670	9,480	11,750	4,680	1,900	46,020	106	58	166

Note 1: Cropping intensities in the extension area are estimated at 110%

Note 2: A part of rainfed paddy has supplemental irrigation facilities.

Furthermore, planted area to diversified crops after paddy harvest in the service area were estimated for each RIS on the basis of the municipal level production statistics. Mungbean and watermelon are the major diversified crops in dry season after second paddy.

RIS	Mungbean	Watermelon	Total	C.I. (%) *
Jalaur Proper	600	100	700	8
Jalaur Extn.	100	10	110	4

Suague	150	20	170	6
Aganan	400	500	900	21
Sta Barbara	200	150	350	12
Total	1,450	780	2,230	10

C.I* : Cropping Intensity (% of planted area against service area)

Cropped area and cropping intensity for each RIS are summarized in Table A.3.21, and cropping patterns are illustrated in Figure A.3.27 in comparison with cropping calendar provided by NIA. The cropping patterns in the extension areas are also significantly dependent on the availability of irrigation water. The extension areas are mostly under rainfed condition, but farmers exert effort to get water for supplementary irrigation using creek and shallow tube well water. Twice cropping of paddy rice can be seen in a small extent even in the rainfed area.

In the extension area of Barotac Nuevo, sugarcane land is managed by estate farming system. The major cropping patterns in the extension areas are shown below:

(a) Paddy - Paddy (supplementary irrigation by pumps),
(b) Rainfed paddy - Fallow, and,
(c) Sugarcane (sugarcane estates in Barotac Nuevo extension area).

(3) Farming practices

Generally, the farming practices for the type of crops mentioned are similar in all the RISs. The common farming practices for major crops; paddy, mungbean and watermelon in the study area are summarized as follows:

(a) Paddy

Cultivation period: First paddy - from May/Jun to Aug/Sep, second paddy - from Sep/Oct to Dec/Jan, third paddy - from Dec/Jan to May/Apr. Growth period in paddy field 95 to 110 days. Farmers in the upstream areas move rice planting forward as soon as possible in order to plant third paddy. This manner disorders the standard cropping season.

Land preparation: Generally plowing done by hand-tractor, leveling done by carabao or hand tractor. It seems that land preparation will be fully done by hand-tractors near future.

Major variety: IR 64, RC 14, RC 18, RC 20, RC 10, and IR 72. Almost 100% of area has been applied to high yielding varieties.

Seeding: Direct seeding is dominant, 85 to 90% of farmers adopt direct seeding. Seeding rate of direct seeding and transplanting are 120 to 200 kg/ha and 80 to 120 kg/ha respectively. The seeding rates are very high comparing reasonable amount, 60 kg for transplanting and 100 kg/ha for transplanting. Application of certified seed from seed grower has not been common, only 15 to 25 % of farmers uses certified seed due to shortage of the distribution of certified seed and high price for farmers financial situation.

Fertilizer: Fertilization rate is N: 93 kg/ha, P: 28 kg/ha, K: 13 kg/ha on average. The amount of fertilizer application is rather high, particularly on nitrogen comparing with present unit yield. 70 % of farmers dose not apply basal fertilizer. Usually farmers apply twice fertilization, 15 to 20 days and 45 to 50 days after seeding, side-dressing for vegetative stage and top-dressing for reproductive respectively. Organic manure are seldom used.

Weed control: Herbicides are generally applied twice per cropping . Manual weeding is not common.

Insect/pest control: Tungro, Grassy stunt, Bacterial leaf blight, Stem borer, Brown plant-hopper and Green rice leaf-hopper are major insects and pest. Generally adopted 2 to 3 times agro-chemicals, insecticide and fungicide. Spraying is done using nap-sack sprayer. Dosing amount of agro-chemicals and timing of application are often not proper due to farmers' financial situation and low knowledge of application method.

Snail and rat control: Damage by golden snail and rat appears seriously recent year. Molloscide for snail is not common use due to high price for farmers financial condition.

Harvesting: Harvesting is done by hand, threshing done by engine thresher. Harvest and threshing are usually done by crop-share-labors which are given 1/8 or 1/7 of the production. Straw after threshing generally is burned in the paddy field. Usually farmers sell moist paddy without drying except family consumption

It seems that proper and appropriate farming technology has not become common among the farmers for production increase, maximization of profit through minimization of production cost, and grading up produced paddy. Especially, present seeding rate, low using ratio of certified seed, fertilization, weeding and plant protection should be improved to appropriate farming technology.

(b) Mungbean

Seeding: Seeds are broadcasted immediately after harvest of paddy using residual soil moisture without plowing

Crop management: Mungbean is cultivated under rainfed condition, generally fertilizer and agro-chemicals are not applied

(c) Watermelon

Land preparation: watermelon is usually planted in seed plots which are plowed at the extent of one meter diameter circle by hand from December to early February after second paddy rice, after typhoon season to avoid water logging damage

Crop management: Field planted is irrigated every day by hand and bucket using dug well water in the paddy field. Application of fertilizer and agro-chemicals is common practice

(4) Farm machinery and labor balance

Plowing/harrowing during land preparation and threshing are carried out by engine farm machinery. Irrigation pumps with 2 - 3 horse-power engine are also common among farmers for supplemental irrigation from creeks and tube well when canal water is in shortage .

Based on the socio-economic survey, the number of farm machinery owned by farmers are shown below.

	Jalaur-Suague	Aganan- Sta. Barbara	Average	
	unit/100farmer	unit/100farmer	unit/100farmer	unit/100ha*
Tractor	3	5	4	1.3
Hand-tractor/Power tiller	53	58	55	20
Sprayer (knapsack)	99	112	103	38
Engine Thresher	23	37	27	10
Irrigation Pump	43	39	42	16

Note *: Computed by average farm size of 2.68 ha.

According to the field interview survey, it takes two days on average to complete land preparation (plowing after soaking, harrowing and leveling) per hectare using hand-tractor, one week/ha using carabao, or half day/ha using tractor. It means that tractor has a working capacity of 4 times of the hand-tractor's, or about 15 times of carabao's. As mentioned above, the number of tractors and hand-tractors owned by farmers are 3.7/100farmers and 55/100farmers, respectively. Average number of hand-tractors per 100 hectares in the study area is about 20. Additionally, there are 1.3 tractors per 100 ha. Whole tractor and hand-tractor in the RIS area have land preparation capacity of 700 ha/day assuming 30% of the operation rate. The working capacity is sufficient for land preparation in the study area.

Owned ratio of irrigation pumps is high, 42 units/100 farmers. Farmers often irrigate paddy field using pump from canal water, creek or shallow tube-well when irrigation water from canals become critically in shortage. Large number of irrigation pumps indicates shortage of irrigation water from the RISs.

There are many land-less households in rural barangays in the study area. The land-less households get their income mainly from farm work as hired labor. According rough estimation basis of total households and number of the irrigation beneficiaries with operating land and field interview with village leaders such as barangay captain and IA presidents, approximately 40 to 60 % of total households are farm-workers. Number of farm-labors engaged mainly in farm work are nearly equal with 100 to 120 % of the irrigation beneficiaries. According the socio-economic survey, labor requirement for a paddy cropping is about 70 man-days, and farmers depend on hired labor 60 % of the total labor requirement on average. Under such situation of labor capability, labor force for paddy cropping is sufficient even in the peak season. Furthermore, in some areas farm labors come into the study area from upland, sugarcane area and Guimaras island during busy season of farming.

Labor requirement for one cropping	manday/ha	70
Labor requirement for peak season	manday/ha/month	30
Family labor (40%)	manday/ha/month	12
Hired labor (60%)	manday/ha/month	18
Average farm size	ha/farmer	2.68
Average labor force		
Family labor	person/h.h	2.0
Hired labor	person/h.h	2.0
Available labor force (assumed at 80% of total mandays)		
Family labor	manday/h.h.	48.0
Hired labor	manday/h.h.	48.0
(100% against number of farmers)		
Labor requirement per farmer	manday/ha/month	80.4
Family labor	manday/ha/month	32.2
Hired labor	manday/ha/month	48.2

3.6.4 Agricultural Production

Agricultural production in the study area was estimated on the basis of NIA reported area and unit yield, field investigation, and production statistics of Iloilo Province and relevant municipalities. The unit yield of major crops is estimated below.

Irrigated paddy				
Wet season (1st paddy)	:	3.40 ~ 3.86	ton/ha	(average yield of benefited area)
Dry season (2nd paddy)	:	3.30 ~ 3.56	ton/ha	(average yield of benefited area)
3rd paddy	:	0.7 ~ 3.0	ton/ha	
Rainfed paddy	:	1.5 ~ 2.5	ton/ha	(included partially irrigated area)
Mungbean	:	0.4 ~ 0.7	ton/ha	
Watermelon	:	3.0 ~ 6.0	ton/ha	
Tomatoes	:	3.0 ~ 5.0	ton/ha	
Sugarcane	:	45 ~ 50	ton/ha	

The following table shows the average unit yield of paddy rice in benefited area by RIS and cropping season. The unit yield of paddy has been low in spite of rather high fertilization as mentioned above. Furthermore, the figures indicate that unit yield in the dry season paddy is lower than of the wet season due to the shortage of irrigation water during the dry season in spite of favorable solar radiation. Shortage of irrigation water is most important cause of low productivity. Average yield of Iloilo Province by BAS is similar to or higer than of RISs in wet season paddy, however, the yield of dry season paddy is lower comparing with the yields of RISs. It is supposed that CIS and private irrigation areas are more difficult in water resouces in the dry season than RIS areas.

RIS	Wet Season (1st paddy)	Dry season (2nd paddy)
Jalaur proper	3.40	3.30
Jalaur extension	3.70	3.43
Suague	3.64	3.41
Aganan	3.56	3.40
Sta. Barbara	3.86	3.56
Iloilo Province * (average of irrigated)	3.97	3.19

Average in recent 5 years (1992 - 1996)
Note * : Refer Table A.3. 19

Based on the estimated unit yield mentioned above, the present crop production in the study area is given in Table A.3.22and summarized below.

(unit: ton)

	Paddy Rice			Mungbean	Watermelon	Sugarcane
	Irrigated	Rainfed	Total			
RIS						
Jalaur Proper	37,010	12,570	49,580	240	400	-
Jalaur Extn.	13,770	2,720	16,490	40	40	-
Suague	15,770	2,320	18,090	60	80	-
Aganan	18,600	3,090	21,690	160	2,000	-
Sta. Barbara	17,970	1,180	19,150	80	600	-
Subtotal	103,120	21,880	125,000	580	3,120	-
Extension Areas	0	14,850	14,850	-	-	91,400
Total	103,120	36,730	139,850	580	3,120	91,400

3.6.5 Livestock

Livestock sub-sector is a minor economic activity in the study area. However many farm households are raising livestock or poultry for supplementary family income and nutrition supply for the family.

Carabaos are traditionally used as draft animal for paddy cultivation, plowing, harrowing and leveling of paddy land. Recently, power tillers have become widely used for land preparation, except for land leveling. Based on the field investigation and interview survey, plowing and harrowing are done for 70 % of the land by power tiller, while 70 % of leveling work is still dependent on carabao. Only 20 % of the farmers are raising carabao, but it is still an important animal for paddy land preparation.

	Jalaur-Suague		Aganan-Sta. Barbara		Total	
	A (%)	B (head/farm)	A (%)	B (head/farm)	A (%)	B (head/farm)
Carabao	27	1.3	16	1.5	20	1.4
Cattle	26	2.1	4	2.7	11	2.6
Hog	46	2.5	43	2.9	44	2.7
Goat	10	3.0	6	2.9	8	3.0
Poultry	67	21.9	73	24.4	71	22.7

A: Ratio of livestock raising farm
B: Average head of livestock per farm

Cattle are raised only by 11 % of the farmers. The cattle feeds are grass and rice straw after harvesting of paddy field. The average number of cattle raised per farmer is 2.6 heads. Cattle for dairy purpose is seldom, and there is no statistics for milk production.

Hogs and poultry are popular livestock in the study area. The ratio of farmers raising hog and chicken is 44 % and 71 % respectively based on the results of the socio-economic survey. Middle/large scale poultry and hog farms have been established in the study area in recent years by enterprise or cooperative type.

Farm compost preparation using livestock manure is recommended by agricultural technicians of the Municipal Agricultural Offices (MAO), however it has not become common.

3.6.6 Summary of Constraints of Agricultural Production

(1) Shortage of irrigation water

Due to the limited water resources for irrigation and deterioration of irrigation facilities as well as inadequate water management, shortage of irrigation water is most serious cause of low productivity of paddy rice. Consequently, the benefited areas in the RIS service area are 69 to 93 % in the wet season, 28 to 70 % in the dry season. Remaining paddy field in the RIS is cultivated under rainfed conditions or fallow. The Jalaur proper RIS is functioning to only 69 % of service area even wet season.

Ratio of Benefited Area in each RIS

RIS	Wet season	Dry season
Jalaur proper	69%	56%
Jalaur extension	84%	62%
Suague	87%	63%
Aganan	93%	28%
Sta. Barbara	90%	70%

Unified cropping calendar has been disordered by farmers eagerness for early harvest avoiding water shortage in the late stage of second paddy cropping, or for cultivation of third paddy. Farmers in the upper stream have higher water availability than those in the downstream area. This manner will make unstable water distribution in downstream area.

(2) Insufficiency of proper farming technology

As mentioned in present farming practices, proper farming technology has not been common in the study area on dosing rate and method of seeding, composition of N : P : K and timing of fertilization, amount and timing of chemical application for weed and pest control etc. Damage by snail and rat also is a serious problem on paddy cultivation. Direct seeding is common in the study area. The seeding method may be one of the causes of low yield due to the difficulty of manual weeding and too high density of rice plants.

(3) Low using rate of certified seed

Certified seed is produced by seed growers who have accredited by BPI. There are 78 seed grower-farmers including. The Western Visayas Integrated Agricultural Research Center (WESVIARC) in the relevant 13 municipalities and Iloilo city. DA and MAO (seed inspector) provide technical services and inspection with seed growers. The seed growers have 720 ha of paddy field for seed production in total, but area actual seed production area is less the 10% of 720 ha. Price of the certified seed is peso 600 to 650 per 40 kg. The socio-economic survey by the study team reveals that the using rate of certified seed is only 12%. Usually farmers replace their seed stocks once in several cropping. It is not uncommon to observe an admixture of paddy varieties grown in the study area.

(4) Degradation of soil fertility

Rice straw is generally burned in the paddy field after threshing. Organic manure and compost such as rice straw and livestock manure is seldom applied. Although soils in the study area have a high inherent fertility for paddy cultivation, if the continuos paddy cropping would be done without application of organic manure the fertility would be decreased.

Lands for three cropping system of paddy rice are mostly under irrigation throughout the year. It is anticipated that the soil under full irrigation will decline in physical and chemical properties because of soil reduction affect.

(5) Problems of crop diversification

Diversified crops can be planted only in the dry season due to the low drainability of the soils in the study area. Mungbean can be grown under rainfed condition using residual soil moisture after harvest of paddy field, however, the yield is low level. Watermelon which is presently a major valuable diversified crop in the study area, is irrigated by hand using dug-well in the paddy field due to stop of water distribution from canal in the late growth stage.

Since farming technology of valuable diversified crops such as vegetables has not generalized among the farmers, the production is still little in spite of big market in Iloilo city. In present the seed supply of vegetables also is not sufficient.