BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
CAPAYAS IRRIGATION
IN
THE REPUBLIC OF THE PHILIPPINES

FEBRUARY 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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P R E F A C E

In response to the request of the Government of the Republic of the Philippines, the Government of Japan has decided to conduct a Basic Design Study on the Project for the Capayas Irrigation and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Philippines a survey team headed by Mr. Yoshiaki Kishi, Deputy Manager, Land Development Division, Construction Department, Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries from August 24 to October 2, 1989.

The team exchanged views with the officials concerned of the Government of the Philippines and conducted a field survey in Manila and Bohol Province. After the team returned to Japan, further studies were made. Then, a mission was sent to the Philippines in order to discuss a draft report and the present report was prepared.

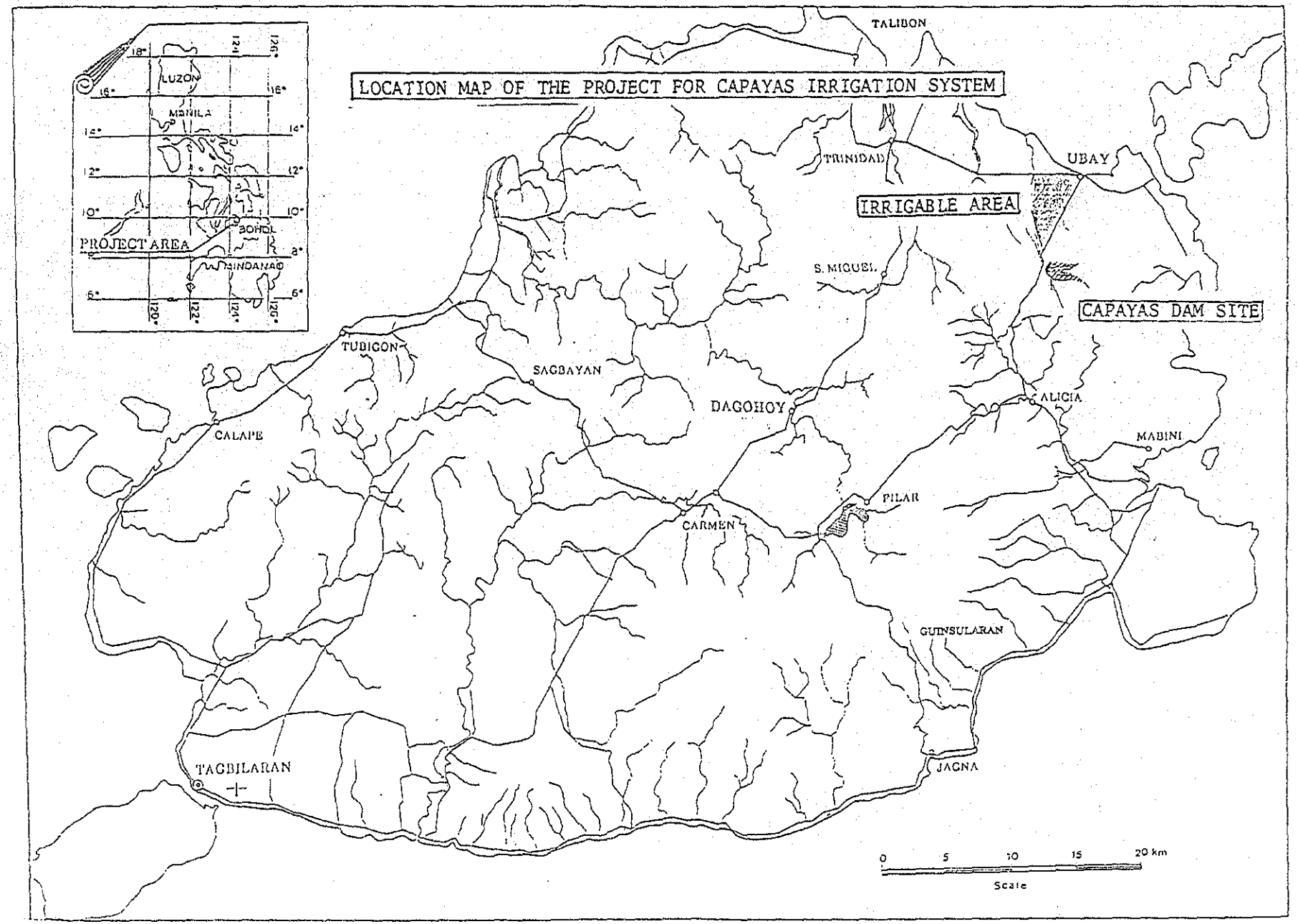
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

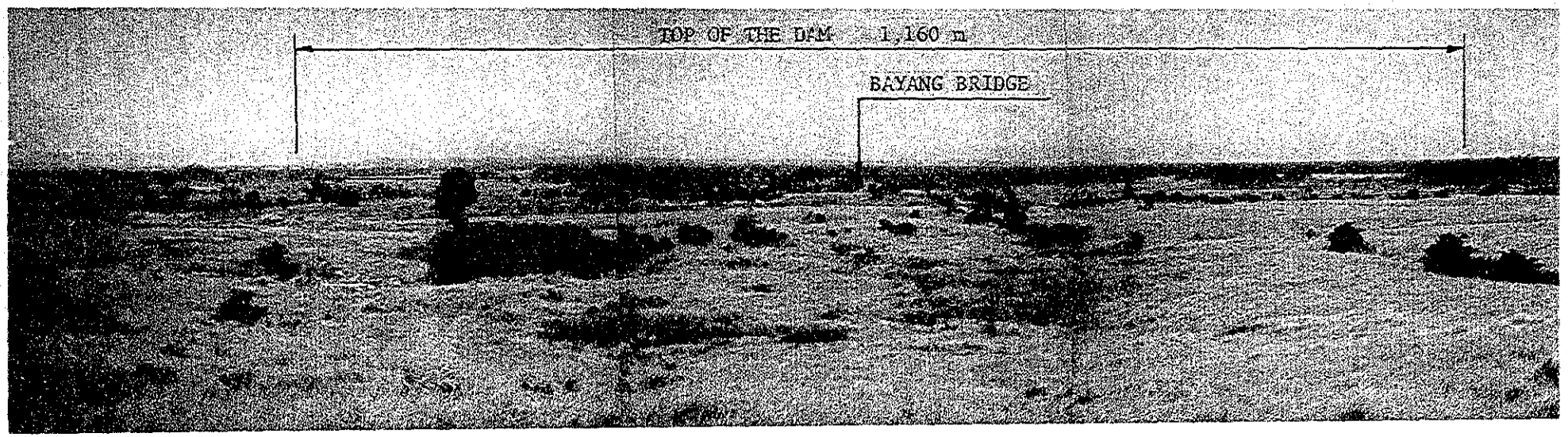
I wish to express my sincere appreciation to the officials concerned of the Government of the Philippines for their close cooperation extended to the team.

February, 1990

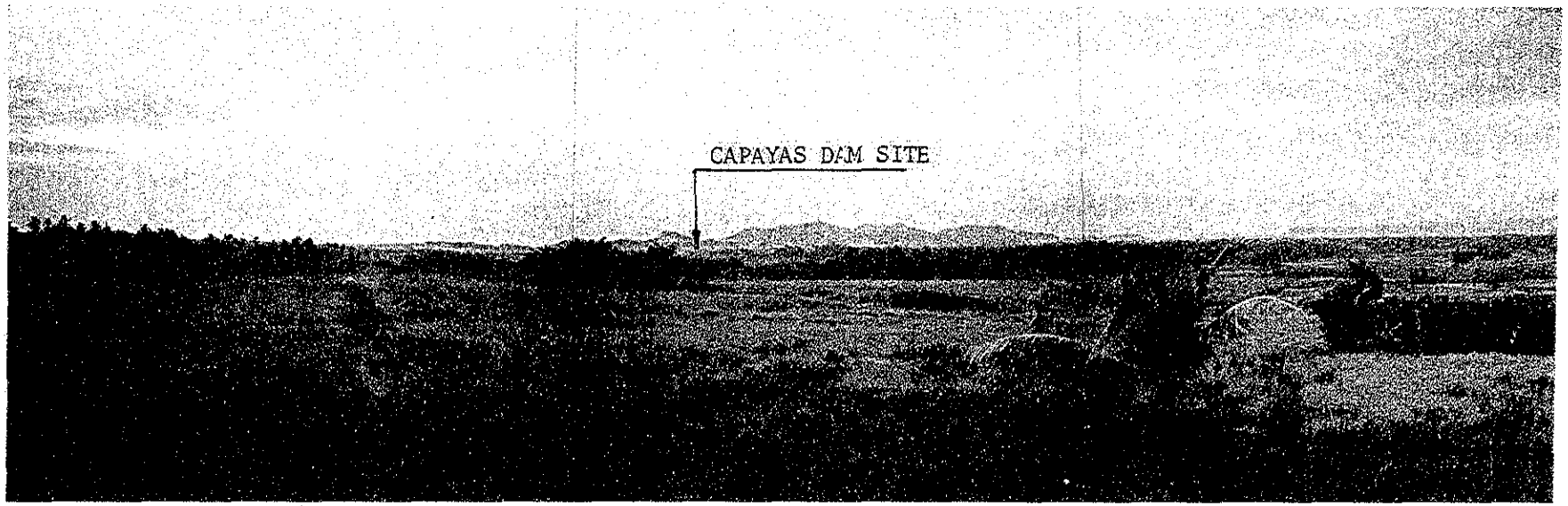
Kensuke Yanagiya

KENSUKE YANAGIYA
President
Japan International Cooperation Agency


LOCATION MAP OF THE PROJECT FOR CAPAYAS IRRIGATION SYSTEM
TALIBON
TRINIDAD
UBAY
IRRIGABLE AREA
S. MIGUEL
CAPAYAS DAM SITE
TUBIGON
SAGBAYAN
DAGOHOY
ALICIA
MABINI
CALAPE
PILAR
CARMEN
GUINSULARAN
TAGBILARAN
JAGNA
LUZON
MANILA
BOHOL
MINDANAO
PROJECT AREA
0 5 10 15 20 km
Scale



PANORAMIC VIEW OF THE CAPAYAS DAM SITE
(A view from the hillside of Ubay Quarry Site)



PANORAMIC VIEW OF THE SERVICE AREA

C O N T E N T S

ABBREVIATIONS

APC	:	Agricultural Promotion Center
APT	:	Agricultural Production Technologist
BIDP	:	Bohol Irrigation Development Project
CARP	:	Comprehensive Agrarian Reform Program
CEDP	:	Community Employment and Development Program
CIS	:	Communal Irrigation System
CIP	:	Communal Irrigation Project
DA	:	Department of Agriculture
DAR	:	Department of Agrarian Reform
DPWH	:	Department of Public Works and Highway
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GRDP	:	Gross Regional Domestic Product
IA	:	Irrigators' Association
IRRI	:	International Rice Research Institute
NAMRIA	:	National Mapping and Resource Information Authority
NCSO	:	National Census and Statistics Office
NEDA	:	National Economic Development Authority
NIA	:	National Irrigation Administration
NIS	:	National Irrigation System
NPC	:	National Power Corporation
OECF	:	Overseas Economic Cooperation Fund
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Service Administration
SWIM	:	Small Water Impounding Management Project
UPLB	:	University of the Philippines, College of Los Banos
VISA	:	Visaya State College of Agriculture

SUMMARY

The Government of the Republic of the Philippines, led by Her Excellency President Corazon Aquino, formulated the Medium-Term Philippine Government Plan (1987-92) in order to achieve immediate recovery from the stagnant national economy through solving the following problems:

i) continuous poverty and imbalanced income;
ii) high unemployment ratio; and,
iii) disparities between urban and rural areas.

Under the Development Plan, the goals are summarized as follows:

i) alleviation of poverty;
ii) generation of more productive employment,
iii) promotion of equity and social justice, and
iv) attainment of sustainable economic growth.

In particular, priority is accorded to the rural development through improvement of farmers' income owing to the increase in agricultural productivity. For this purpose, the development of agricultural infrastructure projects, such as irrigation facilities are now intensively undertaken to alleviate rural poverty and to solve the urban-rural disparities.

The average household income in the Central Visayas Region is significantly lower than the other regions in the country. The rural population transmigrated to Cebu or Manila because of the lack of agricultural infrastructure.

Bohol province, which is located about 700 km southeast of Manila, has a land area of 4,110 sq.km and population of about 930,000, forming an independent province. The major economic activity is agriculture followed by fishery. Agriculture in this province mainly consists of rice cultivation under rainfed condition. Due to uneven distribution of rainfall, the rice yield becomes unstable. Accordingly, food self-sufficiency in the province was not attained and the rural people imported from other provinces.

Under these conditions, the Philippine Government has formulated the Bohol Irrigation Development Project (BIDP) aiming at the expansion of the irrigable area through effective use of the river water. In response to the request of the Philippine Government, the Japan International Cooperation Agency dispatched a Study Team for the feasibility study of Phase I and Phase II of the Project, and later prepared the report on the technical and economic soundness of BIDP.

Meanwhile, the Philippine Government requested technical cooperation from the Japanese Government for the Bohol Agricultural Promotion Center (APC) in order to extend the irrigated farming system for increasing the agricultural production in the province. This project-type technical cooperation was executed by the Japanese Government in 1985 and will expire in 1990.

During the feasibility study, the National Irrigation Administration (NIA) intended to execute the entire BIDP under a yen-loan. For Phase I, the yen-loan was realized, however, it was decided that the implementation of Phase II would be postponed until the completion of Phase I. Due to the delay of implementation of Phase I, the Philippine Government requested grant aid from the Japanese Government for the Project for Capayas Irrigation as the pilot project

of irrigated agricultural development. The service area of the Project, located in the Ubay Municipality, northeast corner of the Bohol Province, suffered from drought due to a lack of water resources. The Project area included Phase II of BIDP, however, the implementation was delayed for a long time.

After considering the request, the Japanese Government decided to execute the basic design study on the Capayas Irrigation Project under the grant-aid cooperation. And the Japan International Cooperation Agency (JICA) dispatched the basic design study team led by Mr. Yoshiaki Kishi, Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries, to the Philippines during the period from August 24, 1989 to October 2, 1989.

The study team held a series of discussions with the staffs of relevant agencies in the Philippine Government, and also conducted a field survey, collecting the necessary data and information for the Project. The basic agreement between the Philippine staffs and the study team is shown in the minutes of the meeting, which was signed by the representatives of both parties on September 1, 1989.

The objective of the basic design study was to prepare the basic design study report of the Project for the optimum scale and contents of the grant aid cooperation based on the review of the contents of the request by reconfirming the background and the feasibility of the Project and reviewing the BIDP (Phase II) prepared by JICA in 1985.

The Study Team surveyed the project site and other major farmlands in the province and confirmed the importance of BIDP (Phase I), which is now implemented under the OECF loan for immediate improvement of on-farm development. Finally, the Study Team judged the necessity of grant aid cooperation for the construction of Capayas Dam and the irrigation and drainage canals for 750 ha of command area as well as the equipment for on-farm development.

The outline of the Project is as follows:

Construction of Irrigation Facilities

(1) Construction of Capayas Dam

Dam Height: 18 m

Dam Length: 1,160 m

(2) Construction of Irrigation and Drainage Canals

Irrigation Canal: 18.7 km, approx.

Drainage Canal: 2.5 km, approx.

(3) Construction of Appurtenant Structures

Maintenance road and control office, etc.

Equipment for On-Farm Development

A. Topo-Survey Instruments

(1)	Distomat including a reflect and tripods	---	1
(2)	Theodolite with tripod	---	2
(3)	Automatic Level with tripod	---	4
(4)	Others		

B. Construction Machinery

(1)	Bulldozer	---	6
(2)	Backhoe	---	3
(3)	Wheel Dozer	---	3
(4)	Motor Grader	---	2

(5)	Dump Truck	---	2
(6)	Truck	---	1
(7)	Truck with crane	---	1
(8)	Pick-up Truck	---	2
(9)	Station Wagon	---	2
(10)	Tractor & Trailer	---	1
(11)	Fuel Tanker	---	1
(12)	Compactor	---	6
(13)	Centrifugal Pump with Diesel Engine	---	2
(14)	Concrete Mixer	---	1
(15)	Spare Parts	---	1

If this Project is executed under the Japanese grant aid cooperation, the undertakings of both governments are as follows:

Japanese Government Side:

(1) Construction of Capayas Dam, irrigated and drainage canals and appurtenant structures.

(2) Supply and delivery of the above-mentioned equipment for on-farm development; and,

(3) Detailed design, tendering, and supervision of the above-mentioned construction works, as well as supervision of supply and procurement of the equipment.

Philippine Government Side:

(1) Necessary arrangement for prompt unloading and custom clearance for the equipment necessary for the project implementation.

(2) Budgetary arrangement and ensuring the necessary personnel for the on-farm development; and,

(3) Budgetary arrangement and ensuring the necessary personnel for operation and maintenance of the irrigation facilities to be constructed.

Out of the total project cost, ₱42.0 million would be provided by the Philippine side annually for operation and maintenance cost of the facilities to be constructed.

The National Irrigation Administration (NIA), which has sufficient experience in undertaking irrigation projects in the Philippines under the assistance of IBRD, ADB and OECF, and others, will be the executing agency of the Project.

It is expected that the detailed design will be completed for 3 months and the construction period for the irrigation facilities will be 12 months.

The direct beneficiaries in Ubay Municipality are about 3,700 farmers whose standard of living could be improved owing to the increase in agricultural production. Furthermore, the indirect effects on the entire area of BIDP (total service area: 13,710 ha) is large owing to the extension of irrigated agricultural technology established by APC and on-farm development technology to be obtained in this Project.

Recommendations made by the Team to the Philippine Government are as follows:

1. It is very essential to complete the construction of dam, irrigation and drainage canal as well as on-farm development to attain the objective of the Project. On-farm development works should be completed within two years using the construction machines which will be

supplied under the Japanese grant aid and on-farm development technology.

2. Farming practices developed by the Bohol Agricultural Promotion Center should be expanded as soon as possible.

3. The Bohol Irrigation Development Project (Phase I) should be completed on schedule so that the budget for the implementation of BIDP-Phase II can be appropriated.

CHAPTER 1. INTRODUCTION

The Government of the Republic of the Philippines established the Medium-Term Philippine Development Plan (1987-92) in November 1986 in order to achieve early economic recovery. The Plan addresses the following problems:

i) continuous poverty and imbalanced income,
ii) high unemployment ratio, and
iii) disparities between urban and rural areas.

Under the Development Plan, the ultimate objectives are as follows:

i) alleviation of poverty,
ii) creation of employment opportunities,
iii) promotion of equity and social justice, and
iv) attainment of sustainable economic growth.

The agricultural development strategy is based on the small investment and quick-return projects in the remote rural area rather than on large-scale project with larger investment.

In particular, the rural development projects focusing on reduction of rural poverty, creation of productive employment opportunities and improvement of living standards in the rural area will be promoted.

Bohol Province, located at the southern part of Central Visayas Region, has a land area of 4,110 sq.km and a population of about 930,000 according to the 1989 Census. The household income of Region VII (including Bohol province) is significantly lower than other regions of the country. Agriculture is the main economic activity in the Province. Rice is cultivated under rainfed conditions in the wet seasons but productivity is unstable due to wide fluctuation of rainfall. Rice cultivation area is reduced by 2/3 in the drought years.

In the hilly area where rice cultivation is not suitable, upland crops such as maize, cassava, sweet potatoes and mungbeans are cultivated under non-irrigated conditions. However, the upland crop cultivation area is small and production is extremely low.

Under these situations, the Philippine Government formulated an the agricultural development plan for expanding the irrigable area by effective use of the river water in the northeastern portion of Bohol Island, and requested technical cooperation for a feasibility study of the plan from the Japanese Government. In response to this request, the Japan International Cooperation Agency (JICA) dispatched a study team for the feasibility study on Phase I and Phase II (after separating the Project Area by the hydrological division), both of which were confirmed to be technically and economically sound.

Meanwhile, the Philippine Government requested grant aid for establishing the Bohol Agricultural Promotion Center (APC) and in this respect, the project-type technical cooperation for the APC has been carried out.

After the feasibility study, the National Irrigation Administration (NIA) implemented the Project under the OECF loan. However, the loan for Phase II was postponed after the completion of Phase I. Accordingly, the Philippine Government requested grant-aid cooperation from the Japanese Government for the Capayas Irrigation Project as the pilot project for irrigated agriculture due to the recent financial crisis and as a means of reducing the debt.

To this end, the Japanese Government decided to execute the basic design study of this Project, and on behalf of the Japanese Government, JICA dispatched the basic design study team led by Mr. Yoshiaki Kishi, Construction Department, Ministry of Agriculture, Forestry and Fisheries to the Philippines during the period from August 24, 1989 to October 2, 1989.

The study team held a series of discussions with the Philippine staffs concerned on the components of the Project, and also conducted a field survey and data collection. Minutes of the meeting giving the basic items agreed upon were signed by the representatives of both parties on September 1, 1989.

The study team made the draft of basic design of irrigation facilities, selection of equipment, cost estimates, and operation and maintenance plan of the Project. JICA dispatched the mission to the Philippines in order to explain the draft report during the period from January 29 to February 4, 1990 and discussed about the details of the Project with agencies concerned.

This report represents the final report after its arrangement based on the discussions in the above period.

CHAPTER 2. BACKGROUND OF THE PROJECT

2-1. General Condition of Philippine Agriculture

2-1-1. Importance of Agriculture

The agriculture sector occupies a very important role in the Philippine national economy. As shown in Table 2-1, the proportion of GDP accounted for by the agricultural sector decreased from 31.5% in 1970 to 26.8% in 1986, and the manufacturing sector increased. The manufacturing sector mainly consists of processing of agricultural products such as copra and fibers.

Table 2-1. Sectoral Composition of GDP

Year	Agriculture (%)	Manufacturing (%)	Services (%)
1970	31.5	25.0	43.6
1975	26.8	34.1	39.1
1980	25.6	36.2	38.2
1985	28.8	31.9	39.3
1986	26.8	28.4	35.7

Source: NEDA, 1985 Economic & Social Indicators.

The agricultural sector, which produces staple foods; namely, rice and maize, export products such as coconuts and sugar, contributes greatly to the national economy. The proportion of agricultural products to total exports are decreasing, however, they still occupied 24% in 1985 (Table 2-2).

Table 2-2. Composition of Exporting Commodities

	1975	1980	1985
	%	%	%
Traditional Export Commodities	80.9	43.9	24.6
Coconut Products	22.3	13.4	9.5
Sugar	28.1	10.1	3.5
Timber	10.7	7.2	4.2
Mines	15.3	9.9	2.1
Others	4.5	3.3	5.4
Non-traditional Export Commodities	18.7	55.4	75.4
Non-traditional Manufacturing	10.6	39.9	66.1
Electric/electronic products	1.0	11.5	22.9
Clothes	3.4	8.6	13.4
Chemicals	0.6	1.6	3.3
Non-metal Products	1.3	1.0	0.5
Machinery, Transport	0.2	0.9	0.8
Fibers	0.3	1.3	0.5
Others	3.8	14.9	24.8
Non-traditional non-manufacturing	8.1	15.5	9.2
Others	0.4	0.3	0

Source: NEDA, 1985 Economic and Social Indicators

The working population in the agricultural sector accounts for about 50% of the total working population in 1985. Agriculture is the sole sector which can absorb unemployed labor force from the urban areas.

It was announced that self-sufficiency of rice was achieved in the beginning of 1980s. However, the supply of rice has not been able to meet demand since 1983.

The climate in the Philippines is a tropical monsoon type which is characterized by wet and dry seasons. Most farmers cultivate rice. Foodgrains such as rice and maize (mainly in Visaya and Mindanao provinces) are predominant in the country. Coconuts, sugarcane, coffee and banana are mainly cultivated for export. Pork is the major animal product followed by poultry, eggs, beef and milk. Fishery is still for self-consumption. Commercial fishing and aquaculture for marketing are becoming popular. As for forestry, export of timber earned large amounts of foreign currency but it is presently prohibited in order to protect the forest from excessive cutting of trees. The forestry development strategy is now being focused on environmental protection.

In the 1980s, the area under cultivation remained the same, while the agricultural population continued to increase. As a result, the cultivation area per farmer gradually became smaller.

Agricultural development in the Philippines is characterized by the following three points:

i) Expansion of the cultivation area ended in the middle of the 1960s, hence intensive farming has become significant owing to the completion of irrigation facilities.

ii) Owing to the results of research on rice varieties and cultivation techniques at the International Rice Research Institute and Philippines Rice Research Institute, rice production has gradually increased.

iii) Because of the high population growth rate, population pressure become stronger. On the other hand, large

plantations of sugarcane, banana and coconuts which were established during the Spanish occupation exist at present. There is a gap of farm-scale between such large plantation and small holders.

Major constraints of agricultural development in the Philippines are summarized as follows:

i) Agricultural infrastructure is still poor. Stable water resources are scarce. Many paddy fields are still under rainfed conditions without irrigation facilities, and the productivity is low and unstable.

ii) Income from export of agricultural products is stagnant due to the international marketing price decline of traditional export commodities such as sugar and coconuts.

iii) Crop diversification is to be promoted in response to the decline of international price of traditional export commodities. Cultivation technology, processing and marketing are also among the constraints of agricultural development in the country.

iv) Agrarian reform is emphasized from the viewpoints of political stabilization and agricultural development.

2-1-2. Agricultural Infrastructure

In 1985, the total area of paddy fields was 310 million ha, of which 53% were rainfed paddy fields without irrigation facilities. In order to increase the agricultural productivity, particularly rice, expansion of irrigable areas and development of irrigation water resources are essential. To this end, the NIA aims at expanding the irrigable area through developing new water resources including various scales of reservoir dams and improving irrigation facilities (headworks and canal networks) for effective use of water resources.

Irrigation facilities are divided into three types shown in Table 2-3 below.

Table 2-3. Number of Irrigation Systems and Command Area

	Whole Country	
	No. of Systems	Area ('000 ha)
Total irrigable area	-	3,100
Irrigation Systems		
National Irrigation System (NIS)	125	580
Communal Irrigation System (CIS)	5,740	530
Pump Irrigation	2,280	360
Total	8,145	1,470

Source: National Irrigation Administration

Under the regulation of the NIA, the national irrigation systems (NIS) are planned and constructed by the NIA and the constructed facilities are operated by the NIA by collecting irrigation fees from the beneficiary farmers. Accordingly, many NIS facilities are being operated effectively.

On the other hand, the communal irrigation systems (CIS) are constructed by the Irrigators' Association under the technical support of Regional Irrigation Administrator or Provincial Irrigation Engineer. Some of the CIS are constructed by NIA but most of construction costs are repaid by farmers under 50-year loans and the facilities are operated by the Irrigators' Association.

Many CIS are not well managed due to lack of technology and funds. Some CIS are inoperative when typhoons occur.

2-1-3. Agrarian Reform

The agrarian reform relates strongly to farm management and productivity. The past Five-Year Plan aimed at an increase in productivity and incomes of tenant-farmers through land transfer. However, Operational Land Transfer and Operation Leasehold have not progressed for decades. In 1987, the present government established the Comprehensive Agrarian Reform Program (CARP). Since then preparation of agrarian reform has been promoted by the Department of Agrarian Reform.

The implementation of CARP will help farmers improve their standard of living. However, after farmers obtain their land, the farmers should make efforts to improve the productivity of the land to repay the loan they have obtained.

2-2. Related Plans and Programmes

2-2-1. National Development Plan

The new government formulated the Medium-Term Philippine Development Plan (1987-1992) in order to revitalize the stagnant national economy. In particular, the following problems are of main concern under the Plan:

i) continuous poverty and unequal income distribution,
ii) high unemployment rate, and,
iii) disparities between urban and rural areas.

The goals of the national development plan are as follows:

i) alleviation of poverty;
ii) creation of employment opportunities;
iii) promotion of equity and social justice; and
iv) attainment of sustainable economic growth.

The average annual rate of economic growth during the period from 1987 to 1992 was set at 6.8%, however, this rate was revised to 6.5% in February 1987. The per capita GNP, which was ¥1,597 at 1972 prices, in 1986 was targeted to increase by 29% in 1992 with an average growth rate of 4.4%. The average annual growth rate of the agricultural sector was set at 5%, and the agricultural sector was projected to account for 26.6% of the total GDP in 1992, while that for manufacturing and service sectors were set at 8.8% (34.7%) and 6.6% (38.7%), respectively.

As regards the social development, improvement of health and nutrition as well as educational levels were proposed. The ratio of households below the poverty line was expected to be reduced from about 60% in 1985 to 45% in 1992 as indicated in the table below.

Table 2-4. Main Economic Indicators in Medium-Term National Development Plan

Population	64.3 million	(urban 44%, rural 56%)
growth rate (%)	2.32 %	
GNP growth rate	6.8 %	(Per capita GNP ¥16,870)
GDP growth rate	6.9 %	
Agriculture growth rate	5.0 %	
Mining/Manufacturing growth rate	8.8 %	
Service sector growth rate	6.6 %	
Poverty improvement target	45.4 %	(59.3%, 1985)
Poverty line	¥2,382/month/family	(National Level)
"	¥3,282 "	(Capital Area)
"	¥2,912 "	(Urban Level)
"	¥2,066 "	(Rural Level)

Source: Medium-Term Philippine Development Plan (1987-1992), NEDA.

Thus, the Medium-Term Development Plan covers all fields for economic recovery, however, priority was given to the increase of farmers' income and creation of employment in rural areas.

As a strategy of the short-term development, the Government launched the Community Employment and Development Programme (CEDP), which sought to generate one million new jobs mostly in the rural areas. This programme gives emphasis to small-scale infrastructure projects such as feeder roads, communal irrigations systems and school buildings. For agriculture, reforestation, seed production, and distribution of farm inputs were given emphasis. An amount of ¥3.9 billion was initially allocated for the third and fourth quarters of 1986 to support labour intensive projects. This programme was implemented nationwide by the different line departments and local government units, with the National Economic and Development Authority (NEDA) serving as the overall coordinating and monitoring body. As of June 1987, the CEDP generated a total of 36,591 jobs, of which some 26,205 jobs or 71.62% was accounted for by the Department of Public Works and Highways.

2-2-2. Regional Development Plan

(a) Central Visayas Development Plan (1987-92)

Under the Medium-Term Philippine Development Plan, each region plays a role in accordance with the regional characteristics. The Central Visayas Region (Region VII) including the Project Area also suffered from the national economic crisis, and the gross regional product reduced by 3.3% annually from 1982 to 1985. Compared with the average household income in 1985 by regions, the average household incomes in Central Visayas Region as well as Bicol and East Visayas Regions were considerably lower than the other regions (Table 2-5).

The region suffers from the following problems;

i) High incidence of poverty and inequitable distribution of income;

ii) High unemployment and underemployment rates;

iii) Low productivity and poor management of local resources;

iv) Rapid urbanization and over-concentration of growth in Metro Cebu; and

v) Lack of basic social facilities and infrastructure in the rural areas.

To solve the above problems, regional development targets are focused on the achievement of the following major development goals:

i) Alleviation of poverty, especially in the rural areas;

ii) Reduction of unemployment and underemployment;

iii) Reduction of population growth to a level at which economic growth and development can be sustained (refer to Table 2-6);

iv) Equitable sharing of the development benefits;

v) Rehabilitation, conservation and effective use of local natural resources to enhance rural productivity; and

vi) Continued provision of physical infractructure and social service facilities necessary for local development.

Table 2-5. Comparison of Poverty Indices by Regions (1985)

Region	Whole Country			Urban			Rural		
Whole Country	2,382	5,576.6	59.3	3,021	1,875.9	52.1	2,066	3,800.7	63.7
Capital Area	3,282	550.5	44.1	3,282	550.5	44.1			
Other than Capital	2,285	5,126.1	61.6	2,912	1,325.4	56.3	2,066	3,800.7	63.7
1	2,374	364.9	52.3	3,093	89.7	56.2	2,139	275.2	51.1
2	2,194	246.3	54.6	2,897	31.3	48.6	2,092	215.0	55.6
3	2,550	420.0	44.4	3,153	178.5	45.2	2,104	241.5	43.8
4	2,471	712.2	55.9	3,048	241.7	50.6	2,174	470.5	59.1
5	2,148	464.0	73.2	2,625	81.3	62.3	2,047	382.7	76.0
6	2,449	632.4	73.1	3,069	154.1	65.0	2,249	478.3	76.2
7	1,982	530.6	68.8	2,426	142.7	58.9	1,819	387.9	73.4
8	2,016	385.4	70.4	2,733	81.9	70.1	1,822	303.5	70.5
9	2,118	316.5	65.3	2,650	47.2	61.6	2,025	269.3	66.0
10	2,262	355.4	66.2	2,952	91.7	65.7	2,022	263.7	66.3
11	2,388	426.0	61.7	2,998	143.1	59.6	2,079	282.9	62.8
12	2,233	272.4	65.2	2,624	42.2	56.8	2,161	230.2	67.0

Source: Medium-Term Philippine Development Plan, 1987-1992.

Table 2-6. Population Projection of Central Visayas Region
(1987-92)

	1987	1988	1989	1990	1991	1992	Annual Growth Rate (%)
Total Population	4,362,062	4,446,459	4,531,179	4,616,046	4,697,290	4,779,974	1.85
Bohol	899,732	913,842	928,092	942,438	956,480	970,732	1.53
Cebu	2,426,444	2,475,182	2,524,013	2,572,826	2,619,266	2,666,544	1.91
Negros Oriental	957,509	977,764	998,098	1,018,480	1,037,933	1,057,758	2.01
Siquijor	78,377	79,671	80,976	82,302	83,611	84,940	1.62

Source: Medium-Term Philippine Development Plan, 1987-1992.

(b) Bohol Province Development Strategy (1988-92)

In line with the national development targets, Bohol Province has formulated a development strategy to alleviate poverty and to acquire a better livelihood.

Under the Plan, the employment-oriented, rural-based strategy was adopted by the national government to achieve economic recovery in the short term, and sustainable growth in the long term. For this purpose, better resources management at the local level is emphasized.

As an agricultural province with denuded forests, unproductive lowlands and damaged/depleted fishing grounds, it should implement programmes designed to rehabilitate, conserve its land and use its land and natural resources effectively in order to address the problems of poverty, unemployment and low productivity in the rural area. Under the above conditions, the watershed management approach to development is essential and an integrated approach in conserving and utilizing the existing land, forestry and fishery resources is required.

i) Improvement of rice productivity through the extension of irrigated paddy fields.

ii) Development of agriculture including soil erosion and agroforestry in the undulating hilly areas, and mixed cropping or crop rotation complemented by livestock and poultry raising.

iii) Development and conservation of watersheds.

iv) Increase in fish production, both coastal and inland.

v) Encouragement and support for non-farm activities such as trading and processing.

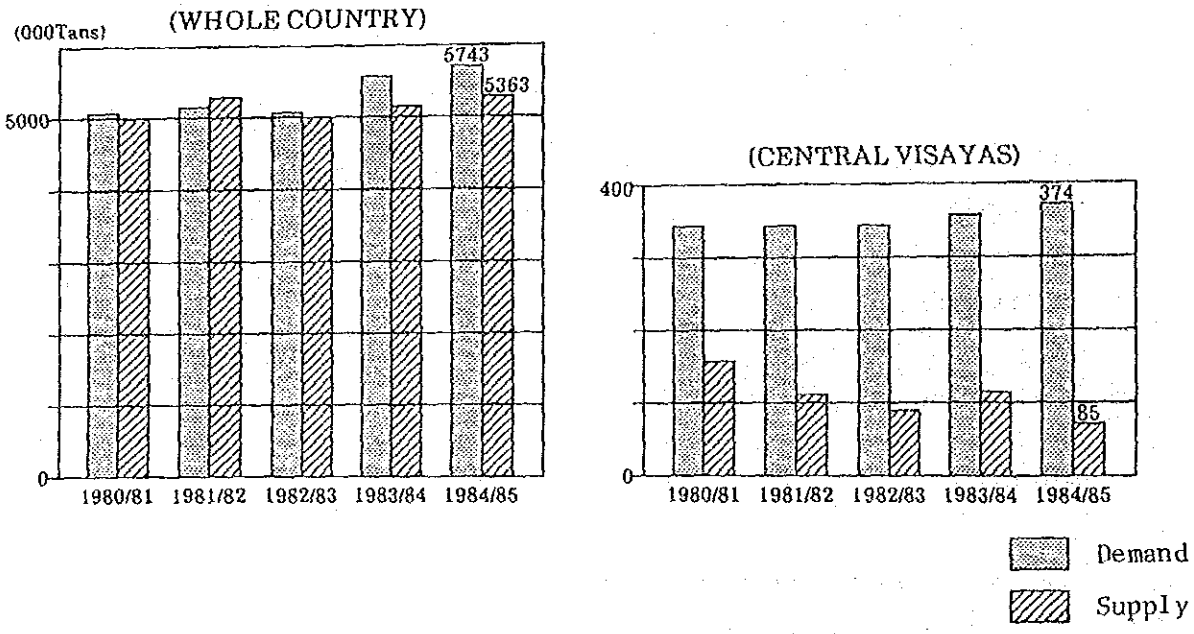
vi) Promotion of rural-based cottages, and small- and medium-scale industries.

vii) Implementation of infrastructure projects.

2-2-3. Agricultural Development Plan

Owing to the investment in and efforts to wards large-scale projects for agricultural development during the 1970s, it was announced that rice self-sufficiency, that is, the primary target of the Philippines, was attained in the 1981/82 crop year. On the other hand, the centralization of national investment in large-scale projects has induced significant disparities of farmers income levels between in the remote rural areas and in the beneficial areas of the large scaled projects. Moreover, many poor rural areas have been created, and this has caused serious problems.

Figure 2-1. Food Supply and Demand



Accordingly, agricultural development is a particular concern in the Medium-Term Philippine Development Plan (1987-92), which was formulated by the new government after considering past development strategy. The agricultural development strategy is based on the small investment and quick-return projects in the remote rural area rather than large-scale project with larger investment.

The basic aim of agricultural development was to lay the foundation for an equitable, efficient, and ecologically sustainable growth in the agricultural sector. The objective is not only to achieve production targets on a competitive basis, but also to increase the real income of the poorer agricultural households. People's participation through farmers' institutions should be recognized as a key factor in bringing about rural/agricultural development.

The agricultural/rural sector focuses on the following objectives:

(a) to enhance small farmers' income;
(b) to sustain the increases in productivity;
(c) to effect an equitable distribution of the returns to production;
(d) to attain food self-sufficiency/self-reliance for improved nutritional well-being;
(e) to create/increase agro-based employment opportunities among the rural population, particularly the landless rural workers and fishermen;
(f) to improve the delivery system for agricultural crops/commodities, farm inputs, and services; and,
(g) to institutionalize the expanded participation of farmers through cooperatives and other farmers' organizations.

The attainment of the objectives of the agricultural sector hinges on the successful implementation of policy and institutional reforms. During the period 1987-92, rice production was expected to grow by about 3.7 percent, while maize was targeted to grow by 6.4 percent. For rice,

the growth was expected to result mainly from the expansion/rehabilitation of irrigation facilities and the adoption of improved technology. To support agriculture, particularly the production of rice and other crops, the total public investment for the rehabilitation and improvement of around 723,000 hectares of existing irrigation facilities and expansion of some 206,000 hectares should involve around ₱19.0 billion from 1987 to 1992. With regard to the maize subsector, priority was placed on the promotion of hybrid yellow corn production in response to a growing market for feeds to support the commercial hog and poultry industries, as well as white corn production for human consumption. The various production programmes for the other food crops which include crop diversification and intercropping mainly in sugar and coconut lands were expected to boost production of these crops to reach self-sufficiency/reliance levels.

Because of the depressed world market prices and the need to diversify, production of sugar over the Plan period was expected to grow by only 1.4 percent. The minimal increase in coconut production of 0.5 percent, from an estimated level of 1.9 million tons in 1987 to about 2 million tons in 1992 took into account the implementation of the coconut rehabilitation and replanting programmes. For the other commercial crops, such as coffee, cacao, mango, etc., the growth in production likewise considered the successful implementation of the crop diversification and intercropping programs as well as the opening up of other world markets for other traditional and non-traditional export crops.

To meet the local and foreign demands of the livestock and poultry industries, livestock production was targeted to grow annually by 2.0 percent and poultry production by 1.6 percent. As to fisheries subsector, the infrastructure support, particularly the development of fishery facilities and regional ports, was expected to contribute to a 3.4 percent growth of fish production.

As a result of crop and fish production, livestock and poultry raising and other farm-related activities, the agricultural sector would continue to absorb 50 percent of the total employment.

Table 2-7. Production Growth Rates by Crops

Crop	Average Annual Growth Rates (1987-92) (%)
Overall	3.9
Food Crops	4.1
Rice	3.7
Maize	6.4
Vegetables	1.7
Rootcrops	1.9
Cassava	4.1
Groundnuts	3.6
Mungbeans	3.2
Others	1.0
Cash Crops	2.1
Coconuts	0.5
Sugarcane	1.4
Banana	2.2
Mango	4.7
Pineapple	2.4
Coffee	6.8
Cacao	7.4
Tobacco	5.4
Abaca	2.1
Rubber	7.2
Others	1.5

Source: Medium-Term Philippine Development Plan, 1987-92

2-2-4. Bohol Irrigation Development Project (BIDP)

This Project aims at supplying water to irrigable land totalling 13,710 ha in the municipalities of Ubay, San Miquel and Trinidad by constructing reservoir dams in the rivers of Pamacsaran, Wahiq, Trinidad and Bayang, which are located in the northeastern part of the Bohol Island. This Project consists of three development phases, and the water resource and irrigable area by each phase are as shown in Table 2-8.

Table 2-8. Irrigable Area by Phases of the BIDP

Phase	Water Resources	Irrigable Area(ha)
Phase I	Malinao Dam	4,960
Phase II	Bayongan Dam and Capayas Dam	5,300
Phase III	Pamacsalan Dam	3,450
Total		13,710

In Phase I, 4,960 ha of irrigable land would be developed by construction of Malinao dam (gross storage capacity 5.99 MCM). The intake capacity totals 11.8 cum/s including the irrigation supply to the Phase II area in addition to 5.5 cum/s for Phase I area.

In Phase II, 5,300 ha of irrigable land would be developed by constructing Bayongan dam in the upstream of Trinidad river and Capayas dam in the Bayang river. The irrigation canal networks can be separated into Bayongan irrigation system (irrigable area, 4,140 ha) and Capayas irrigation system (irrigable area, 1,160 ha). Each irrigation system will be supplied with water from the Bayongan dam or Capayas dam, but their own catchment areas will not be able to cover the entire irrigable area, therefore, these dams will be supplied with supplemental water from the Malinao dam to be constructed in Phase I.

In Phase III, 3,450 ha of land will be irrigated by Pamacsalan dam, which will be constructed in the upperstream of Malinao dam in the Pamacsalan river.

The OECF loan of ¥4,600 million for the implementation of the Phase I development was realized and the construction works have commenced. The construction of Malinao dam will be completed by the end of 1992.

For the implementation of Phase II, the Philippine Government intends to request a loan from the Japanese Government (OECF) depending upon the progress of the implementation of Phase I.

The Phase II development plan consists of Bayongan irrigation system and Capayas irrigation system. This Project Area (750 ha, net) is a part of the Capayas irrigation system of Phase II.

2-2-5. Bohol Agricultural Promotion Center (APC)

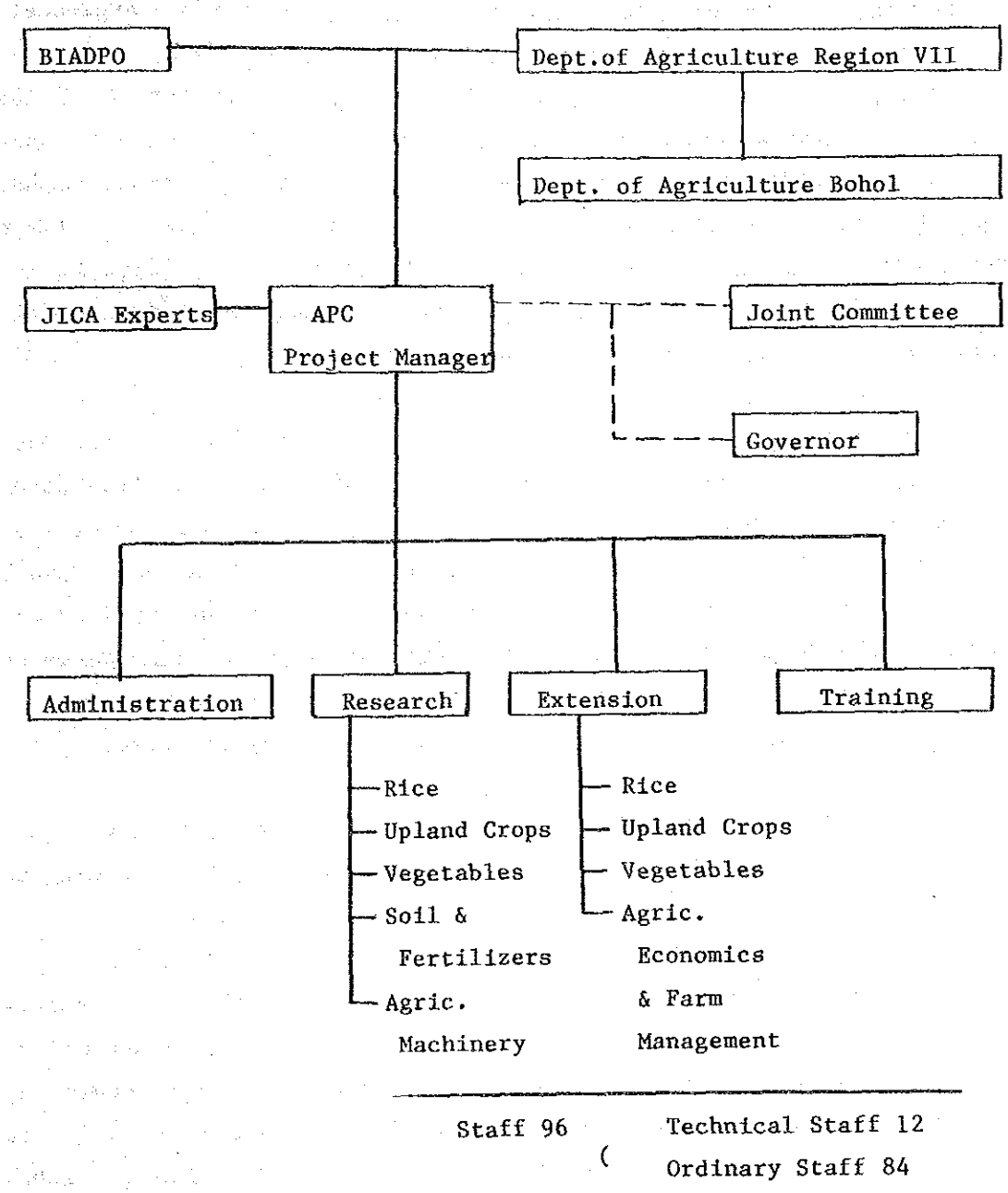
In order to develop and to extend the sound technology for increasing agricultural production and farmers' incomes, the Bohol Agricultural Promotion Center (APC) continues the comprehensive research, extension and training at the Center at Dao and the Sub-Centers at Pillar, Ubay and Tubigon and the Pilot Farm at Carmen under the Project-type technical cooperation of JICA since 1983. The research covers a wide-range of activities such as completing a farm survey on the present agricultural situation, field trials for increasing the production, and seed multiplication of high-yielding varieties. In rice division, yield trial, fertilizer application (phosphate), pest control (Tungro virus) and seed multiplication of high yielding varieties (IR-66 etc.) are being carried out. At the Carmen Pilot Farm, 13 farmers having 1.1 ha each have been cultivating rice by applying APC technology, and obtained more than 10 tons/ha of annual yield in 1985/86. In the upland crop division, for cassava, which is a prospective cashcrop because there is a starch and glucose factory, maize, beans and rootcrops, high yielding varieties adaptability trials, fertilizer application and soil management, and water management etc. are tested. For vegetables, tomatoes, carrots, cabbages and watermelons etc., which are prospectives according to the marketing survey, variety and fertilization experiments etc. are carried out at the Sub-Center at Tubigon. Furthermore, in the soil and fertilizer division, distribution and effectiveness of guano (organic phosphate fertilizer) derived from bat excrement which has been deposited in caves scattered in the Bohol Island. In the agricultural machinery division, trial of suitable mechanization for the present situation of the island is being undertaken.

For extension and training, many demonstration plots are made in cooperation with extension workers of DA and farmer leaders, and APC technology is practised using modern methods with high yielding varieties and proper inputs (fertilizers and chemicals) by farmers themselves. Furthermore, the extension supporting programme is made for production of available inputs, and farmers groups are distributed fertilizers at the market price and repay the loan after the harvest. For seed propagation of high yielding varieties, 2,000 kits each containing 2.5 kg of rice seeds (IR-66) were given to the farmers on the condition that they distribute the harvested seeds to the surrounding farmers. Training and guidance with handbooks and guidelines of seed production for such farmers are given by the APC. To extend the new technology to the surrounding farmers, farmers' forums are held by the farmers who are practising seed production with APC technology at the demonstration plots during the harvesting period. Training at the APC includes long period special training for agricultural production technicians (extension workers), training for farmer leaders and for rural youth. APC staff also takes the training at the International Rice Research Institute (IRRI), University of Philippines, Los Baños (UPLB) and Visaya College of Agriculture (VISCA) etc. as well as overseas agricultural research institutes.

After the training, APC monitors the effect of the training and helps the ex-trainees to carry out a simple fertilizer application trial, pest control checking and Tungro disease test by themselves. And the extension materials written in Bohol dialect are distributed by the APC.

The APC technology has gradually contributed to the agricultural development in the Bohol Province.

Figure 2-2. Organization of Bohol Agricultural Promotion Center (APC)



2-3. Outline of the Request

2-3-1. Background of the Request

Owing to the investment in and efforts to wards large-scale projects for agricultural development during the 1970's, it was announced that rice self-sufficiency, i.e., the primary target of the Philippines, was attained in the 1981/82 crop year. On the other hand, the centralization of national investment in large-scale projects has brought about significant disparities in farmers' income levels between the remote rural area and the beneficial areas of the large scaled projects. Moreover, many poor rural areas have been created, and this has caused serious problems in national security.

The new Government led by President C. Aquino reconsidered the past development strategies and formulated the Medium Term Philippine Development Plan(1987-92) in October 1986. One of the main strategies is agrarian reform, i.e., increase the productivity and income of small holding farmers through distribution of the land to tenant or landless farmers. The basic strategy of agricultural development is to focus on the small investment and rapid return projects in the remote rural areas rather than the large-scale projects requiring large investment.

Bohol Island, which is located in the Central Visayas Region, has a land area of 4,110 sq.km and a population of about 930,000 according to the 1989 census.

The major economic activity is agriculture, which is mainly dependent upon rice cultivation under rainfed conditions. Due to the wide fluctuation of rainfall, the rice cultivation area is reduced by 2/3 in the drought years. The rice yield is low, ranging from 1.0 to 1.5 ton/ha. Accordingly, the total rice production in the Bohol Province is always insufficient to meet the provincial demand. On the undulating hilly land where rice cultivation is unsuitable and is hardly

supplied with irrigation water, upland crops such as maize, sweet potatoes, cassava, and beans are cultivated. But the upland crops cultivation area is small and the crop yields are very low.

Under these situations, the Philippine Government formulated the agricultural development plan to extend the irrigable land by effective use of the river and creeks in the northeastern part of Bohol Island, and requested technical cooperation for a feasibility study from the Japanese Government. In response to the request, JICA dispatched the F/S Study Team for Phase I and Phase II. As a result of the study, the technical/economic feasibility was justified and the feasibility study report was submitted. Meanwhile, the Philippine Government also requested grant-aid from the Japanese Government for the establishment of the Agricultural Promotion Center (APC) and the project-type technical cooperation aiming at developing irrigated agriculture technology and to increase agricultural productivity in the Bohol Province. The technical cooperation for the APC has been carried out since 1985.

The loan for Phase I has been approved, but that for Phase II is to be discussed after the completion of Phase I. The Philippine Government requested grant-aid cooperation for the Capayas Irrigation Project.

The objectives of the Project are as follows:

i) To construct a pilot project of the Bohol Irrigation Development Project (BIDP), which aims to increase the agricultural production and narrowing the gap of the living standards between the rural and urban areas through extension of irrigated land.

ii) To establish engineering methodology on the on-farm development to be applied to the entire command areas of BIDP.

iii) To expand productive farming through the irrigation facilities under the guidance of APC.

2-3-2. Content of the Request

The contents of the request by the Government of the Philippines are as follows:

i) Construction of Capayas Dam

Dam height	:	17.0 m
Dam length	:	1,150 m
Dam storage capacity	:	2.3 MCM

ii) Construction of irrigation and drainage canals

Main canal	:	3.3 km
Lateral canal	:	12.5 m

iii) Execution of on-farm development

Irrigated land	:	750 ha

iv) Construction of water supply system for Ubay

Daily demand	:	3.40 cu.m/day
Annual requirement	:	0.3 MCM

CHAPTER 3. OUTLINE OF THE PROJECT AREA

3-1. Location of the Area

The Project Area is located 6 km southwest of Ubay town at longitude 124°27'East and latitude 10°3' North. Ubay town is located 124 km northeast from the provincial capital of Tagbilaran City. The Project Area is surrounded by the Camote Sea to the north, by municipalities of Mabini to the southeast, San Miguel and Alicia at the southwest and Trinidad at the northwest. Ubay municipality consists of 44 villages and has total land area of 27,217 ha.

3-2. Natural Environment

3-2-1. Meteorology and Hydrology

The climate of Bohol Province belongs to Type-4 characterized by unclear dry and wet seasons. The seasons are roughly separated into dry season from February to May and wet season from June to December. However, there is uneven rainfall distribution, and the monthly and yearly fluctuations are large. Ubay municipality is not covered under the typhoon belt and seldom damaged by typhoon.

The average climatic data during the last six years at Tagbilaran airport are shown as Table 3-1.

Table 3-1. Climatic Data at Tagbilaran

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
Mean Temp.(°C)	26.6	26.9	27.7	28.0	28.5	28.5	27.9	28.7	28.0	27.9	27.8	27.0	27.8
Max. Temp.(°C)	31.1	31.6	32.5	32.9	33.2	32.9	32.0	32.9	32.2	31.9	31.9	31.4	32.2
Min. Temp.(°C)	22.2	22.1	22.9	23.2	23.8	24.0	23.8	24.4	24.0	23.9	23.6	22.4	23.4
Relative Humidity (%)	83.5	81.7	78.7	78.2	77.8	79.0	31.2	78.0	81.8	81.8	84.8	83.6	80.8
Rainfall (mm)	126.7	48.0	57.1	90.5	77.2	90.8	115.5	85.8	176.5	175.9	182.6	113.9	114.4

Source: Records at Tagbilaran Meteorological Station

3-2-2. Topography and Soil

The Project Area is slightly undulating plain. The major area is flat with slope of 0-3% and suitable for rice cultivation. On the slightly undulating land with slope of 3-8%, upland crops such as maize and rootcrops are cultivated. Meanwhile, the hilly land with slopes of 8-15% or 15-18%, which is adjoining the Project Area, is suitable for grassland and fruit growing. The land with slope of 18-30% is to be used for agro-forestry; furthermore, steep sloping land with slope of more than 30% should be left as forest.

Table 3-2. Slope Classification of Ubay Municipality

Slope (%)	Area (ha)	(%)
0 - 3	10,558	38.8
3 - 5	6,581	24.1
5 - 8	5,459	20.1
8 - 15	1,060	4.0
15 - 18	651	2.4
18 - 25	410	1.5
25 - 30	417	1.5
30 -	2,063	7.6
Total	27,217	100.0

Source: Comprehensive Development Plan, 1986-1995
Municipality of Ubay

Soils of the Project Area belong to the Ubay Series. These soils are acidic soils having grayish brown sandy loam to clay textured topsoil with 20-50 cm thickness. Subsoils are reddish brown sandy clay or gravelly clay containing many concretions. Substrata are yellowish brown or reddish brown gravelly layers underlain by shale or sandstone.

Drainage is generally good. The soils dry up quickly without rainfall due to the undulating landform, porous subsoil and substrata.

These soils are subdivided into Ubay Sandy Loam and Ubay Clay.

Table 3-3. Soil Classification of Ubay Municipality

Soils	Area (ha)	Area (%)
Ubay sandy loam	15,486	56.9
Ubay clay	9,891	36.3
Sub-total	25,377	93.2
Faraon clay	806	3.0
Rock outcrop	427	1.6
Swamp	449	1.6
Beach	158	0.6
Total	27,217	100.0

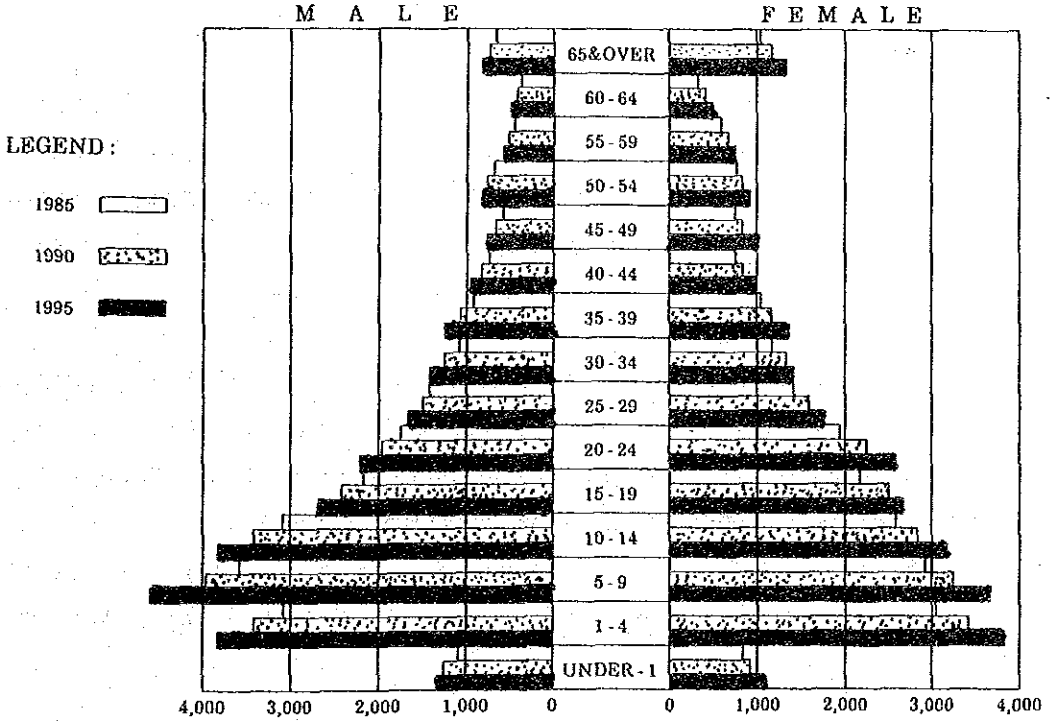
Source: Comprehensive Development Plan, 1986-1995
Municipality of Ubay

3-3. Social Environment

3-3-1. Population and Administrative Division

The total population of Ubay Municipality is estimated at 43,900 and the total number of households is 7,900 (1989 Census). Figure 3-1 shows the age distribution of population in the Municipality.

Figure 3-1. Age Distribution of Population (Ubay Municipality)



The total area of the Capayas Irrigation Project area is 1,230 ha and the net irrigable area is 750 ha. The Project Area covers 5 villages including entire areas of Bayang, Casate and parts of Bood, Clanggaman and Tuboran. The population in the Project Area is estimated at 3,083 and the number of farm households is 500.

Table 3-4. Population Projection of the Project Area

Village	Projection	
	1990	1995
Bayang	948	1,062
Bood	1,428	1,599
Calanggaman	904	1,012
Casate	1,550	1,735
Tuboran	830	929
Total (Ubay)	5,660	6,337

Source: Comprehensive Development Plan, 1986-1995
Municipality of Ubay

3-3-2. Social Infrastructure

a) Transportation

In Bohol Province, there is one airport and six major harbors; namely, Tagbilaran, Jaguna, Union, Ubay, Talibon and Tubigon. Philippine Air Lines has 3 domestic flights per day between Manila and Tagbilaran via Cebu and Aerolift Air Lines has 5 direct domestic flights per week from Manila to Tagbilaran.

Ferries connecting Cebu from Tagbilaran and Tubigon are available daily and ferries connecting Bohol Island and Mindanao are regularly operated from Jaguna. Cargo is usually transported by ship. Except for charter ships, William Lines leave from Tagbilaran weekly.

The total length of national, provincial and local roads in the Province is about 500 km, and they are fairly well maintained. Major national roads are from Tagbilaran to Ubay via Jaguna along the eastern sea coast (Capayas Dam site is located along this road), west-north route from Tagbilaran to Ubay via Tubigon and Talibon, and inland route through Chocolate Hill. Except for Barangay roads, the pavement rate is high. In Ubay Municipality, national, provincial and local roads connect to villages and commercial center.

b) Water Supply

In Ubay Municipality, water supply is insufficient. Presently, there are only two water supply systems being operated in Caya and Ilihan villages by pumping from the dam, however, they are of a small scale and serve only 17 households, or 0.21% of all households. Ratios of different water supply sources are shown as follows:

Table 3-5. Water Supply

Water Source	Ratio
Shallow well	76.0%
Pump	13.7%
Artesian well	6.9%
Springs	2.5%
Rainfall	0.9%
Total	100.0%

c) Power Supply

Bohol Power Corporation II supplies electricity to 17 villages in the Municipality. Out of 7,879 households in Ubay Municipality, 814 households (about 10% of all households) are supplied with electricity. The remaining 90% of households use kerosene lamps.

Table 3-6. Electrification in the Project Area

Village	No. of Households	Electrified Households	
Bayang	150	-	(-)
Bood	232	12	(5%)
Calanggawan	150	6	(4%)
Casate	267	2	(1%)
Tuboran	139	-	(-)
Ubay Municipality Total	7,879	814	(10%)

Source: Comprehensive Development Plan, 1986-1995
Municipality of Ubay

d) Education

The number of people in the education age group, i.e. between 7-21 yrs. old, in Ubay Municipality is 16,041, or 37.4% of the municipality's total population.

Table 3-7. Number of Students in Ubay Municipality

Grade	Student	Ratio(%)
Low grade (7-10 yrs. old)	5,026	31.3
Middle grade (11-12 ")	2,241	14.0
High grade (13-16 ")	3,962	24.7
" (17-21 ")	4,812	30.0

Source: same as above.

There are 16 primary schools, 25 secondary schools and 2 public high schools and 2 private high schools in the Municipality. High grade students (17-21 yrs. old) are mostly attending colleges in Tagbilaran. Some students study in Cebu or Manila.

3-4. Agricultural Situation

3-4-1. Agriculture in Bohol Province

The people in Bohol Province earn their living by farming and fishing. Rice and maize are the main food crop in the Central Visayas Region. Paddy fields are distributed throughout the province, however, most of them are rainfed paddy fields and the production is unstable due to the annual fluctuation of rainfall.

Due to the low productivity, the population transmigrates to Cebu or Manila. As a result, the annual population growth rate of the Province is 1.6%, which is lower than the average of the country (2.7%). According to the National Census and Statistics Office, the total population of the Province in 1989 is estimated at 928,100. About 70% of total employed population are engaged in agriculture or fisheries. The average annual household income in the Province is ₱17,668, which is considerably lower than the national average of ₱30,748. Furthermore, annual incomes of 30% of all households are less than ₱10,000.

Thus, agriculture is the major productive sector in the Province, however, according to the data of Port Agency in 1988, the primary import commodity is rice and flour amounting to 18,655 tons (equivalent to about ₱100 million), followed by maize and sugar. Main export commodities, on the other hand, are galvanized sheets and limestone in addition to copra and cassava products.

Agricultural land in the Province is recorded at 255,000 ha, however, the actual cropped area is 175,000 ha. Out of 35,600 ha of paddy fields, irrigated paddy fields are only 20% of the total. In 1988, 22,000 ha (62% of total paddy fields) were planted and the rice harvested was 60,783 tons. This amount cannot meet the rice demand of 93,213 tons in the Province. Similarly, maize production in 1988 was only 4,795 tons and maize continues to be insufficient. Meanwhile, coconuts are an important cash crop as well as cassava, and about 6 million coconut trees are

planted in 30% of the total agricultural land. Copra was exported to other regions in Visayas and Mindanao and earned ₱60 million in 1988. Livestock is also important for farmers. Ubay Stock Farm exists near the Project Area, but grassland is not fully utilized at present.

Table 3-8. Cropped Area in Bohol Province

Crop	Area(ha)		
Rice		35,556	(20.3%)
Irrigated	11,818		
Rainfed	21,630		
Upland	2,108		
Maize		18,642	(10.5%)
Mungbeans		751	(0.4%)
Groundnuts		2,370	(1.4%)
Rootcrops		27,260	(15.6%)
Cassava	10,995		
Camote	6,337		
Gabi	2,356		
Ubi	500		
Others	7,072		
Vegetables		2,368	(1.4%)
Coconuts		52,874	(30.2%)
Banana		23,842	(13.6%)
Fruits (Mango, etc.)		8,926	(5.1%)
Cacao		1,790	(1.0%)
Coffee		810	(0.5%)
Total		175,189	(100.0%)

Source: PAO, Department of Agriculture, 1989

3-4-2. Agricultural Situation in Ubay Municipality

Agriculture and fisheries are the main economic activities in Ubay Municipality. Ubay Stock Farm is located adjoining the Project Area for livestock development. Total agricultural land including the Project Area is 16,335 ha (60% of the total land area of 21,217 ha). Rice is cultivated on the land with a slope of 0-3% and maize and rootcrops are cultivated on the land with a slope of 3-8%. The rice cultivated area is 7,200 ha (44.1% of the total agricultural land area). Irrigated paddy fields occupy only 1.6%; most paddy fields are rainfed. The yields of one cropping are 4 tons/ha for irrigated paddy, 2 tons/ha for rainfed paddy and 1.5 ton/ha for upland rice. The present rice production is 22,482 tons in the Municipality. Maize production is low, while land condition is suitable for maize cultivation.

Around the farmers' houses, fruits, vegetables, rootcrops, beans and banana are planted. According to the land holding survey, 1,453 farmers are tenant and 624 farmers are registered as owner-farmers under leasehold operations. However, some farmers registered as tenant-farmer own their agricultural land. There are 720 beneficial farmers under CARP in the Municipality.

The most important problem for the farmers is the lack of irrigation water in the paddy fields. The existing CIS in the Municipality in 1986 were as shown in Table 3-9.

Table 3-9. Small-Scale Irrigation System in Ubay Municipality

Name of CIS	Beneficial Area (ha)
1. Biabas	30.0
2. San Pascual	30.0
3. Lumangog	20.0
4. Delina	4.5
5. Garcia	4.0
6. Dida	9.0
7. Union	6.5
8. Antonio	40.0
9. Calanggaman	60.0
Total Gravity	204.0
Pump Irrigation	13.0
TOTAL	217.0

Source: Comprehensive Development Plan, 1986-1995
Municipality of Ubay

The actual irrigated land is only 3.6% of the total potential irrigable land (6,041 ha) in the Municipality. In the rainfed paddy fields, the cropping cycle of wet and dry seasons fluctuate by years due to unanticipated climatic conditions. In addition, increasing the costs of production inputs such as fertilizers is a serious problem, and many farmers obtain loans from the merchants and repay by rice or maize crops after harvest. In Ubay Municipality, Sub-center of APC is located in the Bohol Agricultural Experimental Station and a municipality agricultural officer (MAO) and 5 agricultural production technicians (APT) of the Department of Agriculture are engaged in extension works despite the lack of transportation facilities.

The long-term development plan of Ubay Municipality aims at improvement of rural infrastructure for living conditions, increase in household income, attainment of food self-sufficiency in the municipality and the province through establishment of better socio-economical and living environments by proper use/management of land resources. Firstly, more irrigation reservoir dams should be constructed for the agricultural infrastructure in order to raise the agricultural productivity. The development strategies of agricultural development in the Municipality are as follows:

i) to increase the agricultural products and to achieve food self-sufficiency;
ii) to improve the farming technology through demonstration and training;
iii) to extend the irrigable paddy fields;
iv) to diversify the cropping and to make the farm management more intensive;
v) to strengthen agricultural cooperatives in order to improve the agricultural product marketing.

Whilst the practical strategies of agricultural development are as follows:

i) to establish irrigation systems because the flat land will be the main rice producing area in the Province;
ii) to utilize organic fertilizers such as guano, animal manure, and green manure instead of expensive chemical fertilizers;
iii) to organize farmer leaders through enhancement of extension activities:
iv) to organize the farmers by Samahan Nayon and Farmers Association.

Moreover, the basic concepts of land use in the Ubay Municipality include agro-forestry and pasture development other than rice cropping as follows:

(Land Slope)

0 - 5%	Rice, maize, cash crops (coconuts, root crops, banana, beans)
5 - 8%	Terrace and contour farming
8 - 15%	Grassland, grazing, fruits/*
15 - 25%	Agro-forestry, fruit trees and timber wood/*

/* : not included in the Capayas Irrigation Project Area.

The Project Area includes 5 villages and the total number of farm households is estimated at 500. Out of the total area, irrigable land covers 750 ha. The Project Area is somewhat undulating topography and covered by the soils belonging to Ubay Series. These soils are acidic with grayish brown, sandy loam to clayey textured topsoils of 25-50 cm thick. The drainage is generally fair and soil dries up quickly, especially when there is no rain. At present, rice is cultivated under rainfed conditions in 330 ha of lowland along creeks. In addition, there are upland fields, but most upland area ares now cogon grasslands. In the Project Area, there is no communal irrigation system (CIS).

Table 3-10. Cropped Area in Ubay Municipality

Crop		Area
Rice		7,200
Irrigated	115	
Rainfed	5,600	
Upland	1,485	
Maize (white & yellow)		235
Beans (mungbean and groundnuts)		150
Rootcrops (cassava, sweet potatoes, gabi, ubi)		2,500
Vegetables		75
Sugarcane		75
Coconuts		5,225
Banana		300
Fruits (mango, etc.)		500
Coffee and cacao		12
Others		63
TOTAL		16,335

Source: Municipality Agricultural Officer

CHAPTER 4. OUTLINE OF THE PROJECT

4-1. Objectives

The Bohol Irrigation Development Project (Phase I and Phase II) was formulated aiming to increase agricultural production and to solve the gap of living standard between rural and urban areas through expansion of irrigated area and introduction of modern irrigated agriculture. Phase I is presently being implemented under the yen-loan for construction works of dam and main canal. In addition, the project type cooperation for the Bohol Agricultural Promotion Center (APC), which aims to establish the suitable technology for increasing agricultural productivity and farmer's income in Bohol Province, has been carried out by JICA.

The Project for Capayas Irrigation System, which is a part of the BIDP Phase II, aims at realizing the modern irrigated agriculture applying the technology developed by the APC, through (1) construction of Capayas Dam, (2) construction of irrigation and drainage canals, and (3) development of on-farm facilities (750 ha).

4-2. Review of the Request

4-2-1. Justification and Necessity of the Project

The BIDP aims at developing irrigable area of 13,710 ha in municipalities of Ubay, San Miguel, and Torinidad through construction of four dams in northeastern part of Bohol Island. BIDP-Phase II consists of the Bayongan Irrigation System (irrigable area: 4,140 ha) supplying water from Bayongan dam and the Capayas Irrigation System (irrigable area: 1,160 ha) supplies water from Capayas dam.

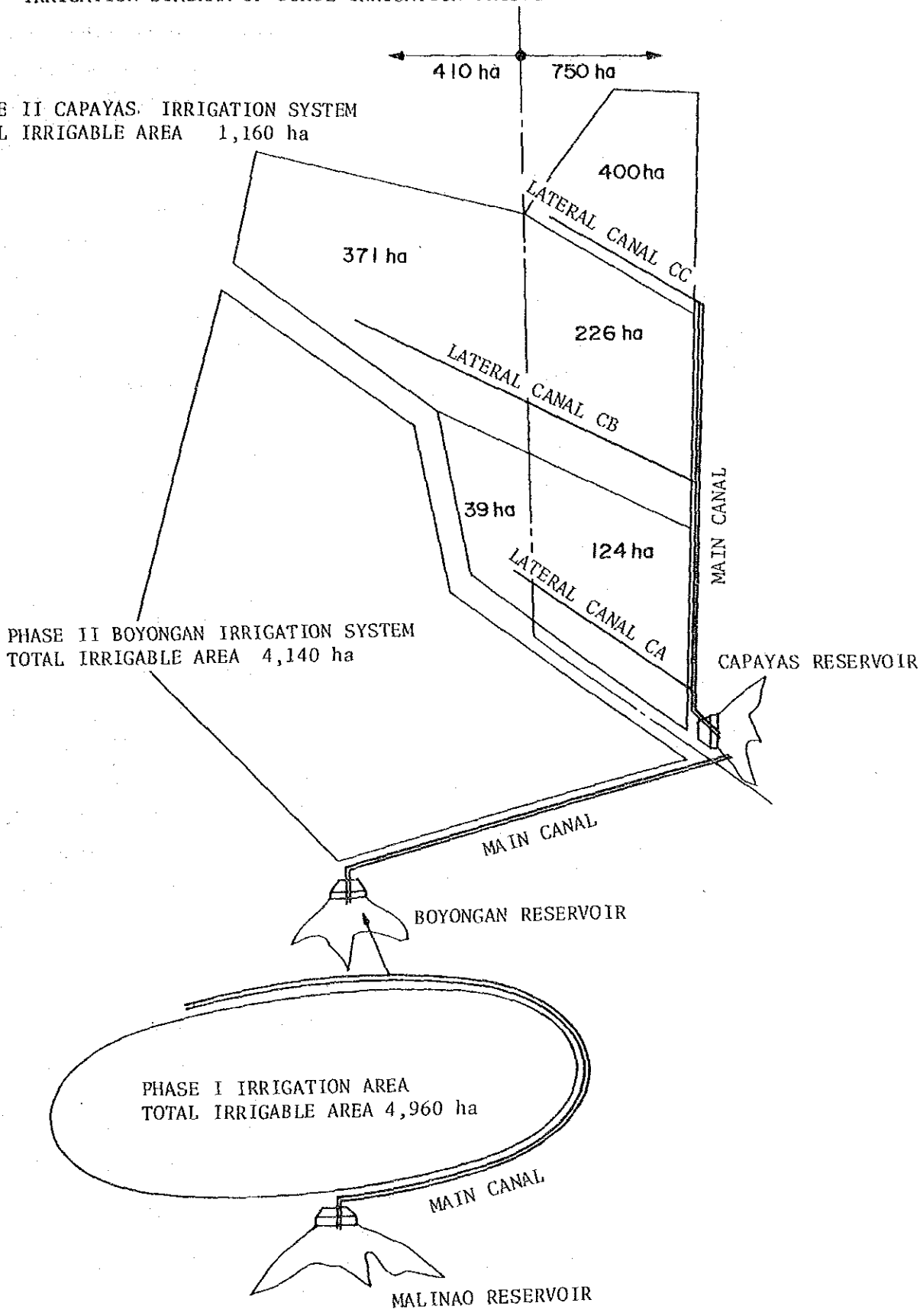
For the purpose of supplying the remaining water from the Phase I Area to the Phase II Area, two main canals will connect Malinao dam to Bayongan dam, and Bayongan dam to Capayas dam. According to the water use plan formulated in Phase I and Phase II studies, Capayas dam was considered a regulating reservoir although it has its own catchment (Figure 4-1 refers).

The Project having been requested is located at the northwestern part of BIDP Area and is (1) to construct the Capayas dam and irrigation and drainage canals for 750 ha of irrigable land in Ubay Municipality, (2) to execute the on-farm development of 750 ha of land, and (3) to construct the water supply system for Ubay town. In the Project area, 3,083 persons (500 farm households) are living. The direct beneficiaries are those farmers and additional 617 persons (100 households) who are living neighboring areas.

Construction of irrigation projects are administrated by NIA in the Philippines. Water source facilities such as dam, headworks, pumping station etc. and main and lateral irrigation and drainage canal are constructed by NIA; on the other hand, on-farm development is conducted by farmers under the direction of NIA. On-farm development of 750 ha should be conducted by farmers under the direction and assistance of NIA using the construction machinery procured by NIA. The storage water from self catchment of the Capayas Dam will be not enough to supply the domestic water to Ubay town in addition to irrigate 750 ha of land. Therefore, the water supply system for Ubay town will be executed at the time of Phase II when supplemental water is available from the Bayongan dam.

More than 50 percent of the total area (40,800 ha) will be developed in the Bohol Province. The present and the planned area of field irrigation in the Province as of December 1988 is shown in Table 4-1. The new development plan involves irrigation and drainage canals, and on-farm development of thousands of hectares of new fields in order to fulfill the new fields of development in a planned manner, gain

FIGURE 4-1 IRRIGATION DIAGRAM OF BOHOL IRRIGATION PROJECT



experience and give intensive training to the staff for the Project. For this purpose, a part of Capayas Irrigation System (750 ha) is to be allocated as a pilot scheme for the whole of BIDP, and further training for developing new fields is also necessary for NIA staff.

Table 4-1. Irrigable Area on the Bohol Island

Present Area	7,690 ha
BIDP Phase I Area (U/C)	4,960 ha
BIDP Phase II Area (Planned)	5,300 ha
BIDP Phase III Area (Planned)	3,450 ha
SWIM Project (75 locations, planned)	16,045 ha
Pumps & Farm Ponds (Planned)	3,355 ha
Total	40,800 ha

Note: 1) BIDP = Bohol Irrigation
2) U/C = Under construction

As mentioned above, the Capayas Irrigation System is part of BIDP-Phase II and has its own catchment system originated at the Capayas Reservoir which functions as regulating reservoir of the Project. The Capayas Irrigation System covers 1,160 ha and the net irrigable area of the Project consists of 750 ha. The water necessary for the Project Area can be supplied satisfactorily with its own catchment system. In view of this, the Project is therefore considered feasible, and should be implemented.

4-2-2. Examination of Executing Agency

The executing agency of the Project will be the National Irrigation Administration (NIA).

The National Irrigation Administration has the following functions and powers:

1) To investigate and study all available and possible water resources in the Philippines, primarily for irrigation purposes.

2) To plan, design, construct and/or improve all types of irrigation projects and appurtenant structures.

3) To operate, maintain, and administer all national irrigation systems.

4) To supervise operation, maintenance and repair or otherwise administer temporarily when necessary, all communal irrigation systems constructed, improved and/or repaired wholly or partially with government funds.

The present organization of NIA is shown in Figure A-4-1 in the Appendix. The Administrator of NIA is appointed by the President and is responsible for the services of the NIA based on the approval by the Board of Directors consisting of the following members:

Table 4-2. Board of Directors of NIA

Chairman	:	Secretary of the DPWH
Vice Chairman	:	Administrator of the NIA
Members	:	Director-General of the NEDA
	:	Secretary of the DA
	:	President of the NPC
	:	Representative of the farmers

NIA had a total of 21,188 employees as of the end of 1988, and it is broken down as follows:

Table 4-3. Personnel of NIA

		Monthly	Daily	Total
a)	NIA proper	8,062	3,734	11,796
b)	Foreign Assisted Projects	2,955	5,970	8,925
c)	Others			467
	Total			21,188

NIA's operating budget for FY 1989 according to the Request Application is as follows:

Sources of Funds: 4,799 million Pesos (about 223 million $)
Expenditure : 4,799 million Pesos (about 223 million $)

A special office in NIA shall be set up for the implementation of the Project. This office will function for a short period of time, and the Project staff who will be assigned in this office will hold two assignments at the same time.

In 1989, the following organizations were established similar to the previous grant-aid irrigation dam project:

Situation of the project	:	Designated as a Small Reservoir Irrigation Project of NIA (NIA-SRIP)
Name of the management	:	Project Management Office of SRIP of ((project name) (PMO-SRIP- (project name))
Current post	:	Head, Dams and Reservoir Section, Project Development Department, NIA

The project manager will be officially called the Project Coordinator (project manager level), and will perform coordination and liaison activities on all matters related to the project with JICA, NIA Regional and Provincial Offices, related Province and Municipal Government Offices, and other agencies concerned. At the same time, he will be designated Head of the Project Management Office - Small Reservoir Irrigation Project (PMO-SRIP).

In the Project for Capayas Irrigation System, the designation of the project management could be done in the same manner as that of the previous project, and an executing organization similar to the Basic Design Study Team will be designated.

At the project site, the Provincial Irrigation Engineer Office will be responsible for the Project and will make a proposal of their executing organization headed by the Provincial Engineer (See Figure A-4-2 in the Appendix). The on-farm development project covering 750 ha and the supply of construction equipment under the grant-aid will be executed by the Provincial Office.

Originally, NIA executes its works on force account basis and occasionally undertakes construction works of other agency's projects as a contractor. In Bohol Province, for instance, NIA undertook construction works of pilot farms of the Bohol Agricultural Promotion Center (APC) under the Department of Agriculture, and is also currently undertaking the construction of the Calanggaman Dam for the Department of Public Works and Highways (DPWH). These construction works are carried out locally by the Provincial Irrigation Office, which maintains and manages the Construction Unit effectively, therefore, the Office has the capacity to perform the construction works of the on-farm development of the Project.

For the budgetary arrangements, NIA has much experiences in grant-aid projects under Japanese assistance, and is well prepared to take necessary measures. NIA proposes the appropriate estimates for site execution of the Project for the coming fiscal year.

4-2-3. Examination of the Related Projects

There are a number of development projects on the Bohol Province such as the National Irrigation Project (Bohol Irrigation Development Project (BIDP), SWIM Project, Pumps & Farm Ponds Project, etc. And among these projects, BIDP is related to the Project.

(a) Outline of BIDP and its Progress

BIDP involves construction of four dams in order to irrigate a total area of 13,710 ha as shown in Table 2-8.

Phase I development plan was implemented under the OECF loan amounting to 4.0 billion yen. The construction work of the trunk irrigation canal, which only began recently. The Malinao Dam construction work will commence as soon as the contract of the work is verified. The dam construction work is expected to be completed by the end of 1992.

The Government of the Philippines will make a further loan request to the Government of Japan for Phase II of BIDP, depending on the progress of the Phase I works.

(b) Relationship of BIDP to the Project

The Project is part of BIDP Phase II work. The Capayas Dam will supply sufficient water for irrigation of 750 ha of the fields in the wet year. The Project is envisaged as a pilot project in which modern technology is developed by APC for the BIDP Phase II work as a whole.

4-2-4. Examination on the Requested Facilities and Equipment

The requested facilities and equipment are as follows:

(a) Requested Facilities

1) Capayas Dam (H=18m, L=1,160m)
2) Irrigation and Drainage Canals (trunk irrigation canals, 3.3 km, branch irrigation canals 15.4 km, drainage canals 2.5km)
3) Appurtenant structures (maintenance road, office building, etc.)

In order to improve agricultural production of the Bohol Province as a whole, especially the improvement of self-sufficiency of food in the Province, it is necessary to:

1) develop and utilize the irrigation system within the framework of the farming system established by NIA, and eventually establish a field irrigation system in the area;

2) establish and gain knowledge/experience in developing new fields;

And in order to achieve the above target, immediate construction of the requested facilities must be made.

(b) Requested Equipment

1) Surveying Equipment

Distomat	1
Theodolite	2
Automatic Level	4
Surveying pole	20
Measuring tape (50m)	6
- do - (100m)	6
Planimeter	2

The construction works for the on-farm development are primarily conducted by the Government of the Philippines upon receipt of the construction machinery. However, for the successful completion of the construction works with a high standard of accuracy, surveying work is one of the essential elements. Of the requested equipment, ten out of twenty survey poles should be replaced by survey rods which are necessary for surveying ground elevation in conjunction with automatic level. The provision of Distomat should include reflector.

2) Construction Machinery

Buldozer (14 ton class)	2
Hydraulic Excavator (0.35cu.m)	6
Wheel loader (1.0cu.m)	2
Motor grader	2
Dump truck (6 ton)	1
Crane truck	1
Pick-up truck	2
Station wagon	2
Selfloader	1
Tank lorry (4.0cu.m for fuel)	1
Compactor (small)	6
Pump (100mm)	2

The above construction machinery granted for on-farm development will cover the existing fields (320ha) and the new development area (430ha). The on-farm development to be conducted within the existing fields involves the construction works for drainage canals while the new development area involves construction works for drainage canals and the levelling of fields. Thus, the drainage canal construction work for the area of 750 ha and the levelling work of new fields for the area of 430 ha are the major works involved in the Project.

For the on-farm development, hydraulic excavators, dump trucks, trucks, pick-up trucks and small compactors are mobilised while the levelling works of the new fields require bulldozers, wheel loaders, motor graders, dump trucks and trucks. Some other pick-up trucks, self-loaders, tank lorries and ϕ100mm pumps are the equipment commonly used for the works carried out both in the existing fields and the new fields to be developed. In addition to the above equipment, concrete mixers will have to be provided for the Project, the details of which are discussed in Chapter 5 "Basic Design".

4-2-5. Basic Concept for Cooperation

As described above, the benefit and necessity of the Project and capability of NIA were confirmed. The basic design of the Project will be carried out based on the Japanese grant-aid. However, part of the request by the Government of the Philippines will be revised.

4-3. Description of the Project

4-3-1. Executing Agency and Operational Structure

After completion of the Grant-Aid Program, further execution and arrangement for operation and maintenance of the Project shall be done

by NIA. The organization of NIA is shown in Figure A-4-1 in the Appendix.

Because of the local irrigation project, actual arrangements for the Project after the grant-aid programme shall be done by the Provincial Irrigation Office. In particular, the works of on-farm development utilizing construction equipment provided under the Grant-Aid shall be executed directly by the Office on force account base.

Figure A-4-2 in the Appendix shows the local organization of NIA, of which the related sections and numbers of staff are as follows:

Project Manager, Capayas Irrigation Project	1
Construction Supervision Staff, Dam and Canal	2
On-Farm Facilities Development Staff	49
Operation and Maintenance Unit	7
Total	59

As mentioned above, there are only two construction supervisors for the dam and canal under the Grant-Aid Program and these supervisors shall act as site coordinator.

4-3-2. Location and Conditions of the Project Site

The Project site is located in Ubay on the northeastern part of Bohol Island, and the area is accessible by road from Tagbilaran via the east coast road over a distance of 124 km. Ubay Province has an area of 207.55 sq.km and consists of 44 villages. Its population is 43,900 (1989 estimate) and the number of household is 7,300 (1989 estimate). The total area in which the Project takes place is 1,230 ha and the Project site for irrigation development is 750 ha, which spreads over five villages. The majority of the Project site is within the boundaries of Bayang and Casate villages, and the other parts are in Bood, Calanggaman and Tuboran villages. The projected population in the Project site is 3,083. (500 farm households).

The topography of Ubay Province is generally hilly to the east of the road which runs through the province while the area to the west of the road is generally flat with some rolling hills. Within the flat area to the west of the road, Bayang River and Son-oku River and their tributaries are developed and form low land. The existing road network ranging from the national highways to the provincial roads provides the necessary access to various parts of the province. Electricity, which is generated by diesel generator, is supplied to Ubay City, Bood, Calanggaman and Casate villages. There is no telephone network in Ubay Municipality.

4-3-3. Outline of Facilities and Equipment

Facilities

1) Construction of Capayas Dam
   (dam height 18m, dam length 1,160m)

2) Construction of Irrigation and Drainage Canals
   (main irrigation canal 3.3km, secondary irrigation canal 14.6km, drainage canal 2.5km)

3) Construction of Appurtenant Structure
   (maintenance road, control office, etc.)

Topo-Survey Instruments

1)	Distomat	1
2)	Theodolite	2
3)	Automatic Level	4
4)	Rod (Stadia)	10
5)	Pole	10
6)	Measuring Tape (50m)	6
7)	Measuring Tape (100m)	6
8)	Planimeter	2

Construction Machinery

1)	Bulldozer (14 tons)	6
2)	Backhoe Wheel-Type (0.35 cu.m)	3
3)	Wheel loader (1.0 cu.m)	3
4)	Motor Grader (110 PS)	2
5)	Dump Truck (6 tons)	2
6)	Truck with Crane (6 tons)	1
7)	Crane Truck (6 tons)	1
8)	Pick-up Truck (0.5 tons)	2
9)	Station Wagon	2
10)	Tractor & Trailer (20 tons)	1
11)	Fuel Tanker (4,000 liter)	1
12)	Compactor	6
13)	Centrifugal Pump (ø100mm)	2
14)	Concrete Mixer	2
15)	Spare Parts	1

4-3-4. Maintenance Plan

The organization will maintain the irrigation facilities upon completion of the Project will be the Bohol Provincial Irrigation Office until the BIDP Phase I & II works are completed. This plan will be divided into "Maintenance Stage I" and "Maintenance Stage II". Upon completion of the entire BIDP works, the Bohol Irrigation Maintenance Office will take over the whole Project. During Maintenance Stage I, under the supervision of the head of Provincial Office for Irrigation, there will be two Gatekeepers, who operate gates for water supply and conduct hydrologic observation and recording, four ditch tenders who conduct general maintenance work for the irrigation facilities; and the Water Master, who controls overall water utilization and its plan of the Capayas Irrigation System.

Annual cost for the maintenance of irrigation facilities is estimated as follows:

Water Master	6,800₱/month x 12 =	₱ 81,600
Gatekeepers	2 persons x 6,200 x 12 =	148,800
Ditch Tenders	4 x 3,000 x 12 =	144,000
Fuel and other operational cost	=	10,600
Total		₱385,000

CHAPTER 5. BASIC DESIGN

5-1. Design Policy

The objective of the Project is to formulate the basic design policy of such irrigation facilities as Capayas Dam, irrigation canal and drainage canal, as well as to consider the construction equipment required for the on-farm development. The design policies of the Project are as follows:

i) Natural factors on the design of the facilities, especially the dam design (Design Flood, Seismic Force etc.), should not be applied at a hand-book level.

ii) In selecting the types of structures, the natural and social conditions of the project area will be fully considered. Especially the water intake and conveyance from the dam to the beneficial area will be applied in a suitable level of facilities for operation and maintenance.

iii) In the event that other construction equipment and/or materials for on-farm development cannot be procured from foreign countries, domestic procurement will also be studied as an alternative on those possibilities, accessibilities and qualities and then the design will be performed. Recently, supply of cement in the Philippines has been unstable, therefore, application of dam type and on the design of appurtenant structures will be considered. Special equipment and materials for intake gates may be available in the Philippines, but the quality should be carefully examined.

iv) The level of the project facilities and/or degree of specification of the construction equipment for on-farm development shall be along those conditions mentioned above. This Project is suitable for Japanese grant-aid.

v) The project should be implemented taking into consideration the framework of Japanese grant-aid programme, such as construction period, etc. Therefore, the dimension and scheduling of the river diversion works essential for the dam construction shall be examined carefully by analysing the climatological and hydrological conditions of the area in detail.

5-2. Study and Examination of Design Criteria

Conditions and criteria for the basic design and cost estimate of the Project are examined as follows:

5-2-1. Topographical conditions (materials)

Topographic map	S=1/50000	(1988,NAMRIA)	;	for catchment area
do	1/4000	(1985,JICA)	;	reservoir capacity, dam layout, canal location, etc.
do	1/10000	(1985,JICA)	;	general layout
do	1/2000	(1982,NIA)	;	land purchase for reservoir
do	1/500	(1989,JICA)	;	basic design, dam
Profile, Dam axis	1/1000	(1985,JICA)	;	dam layout on the F/S,Ph.II
do	1/500	(1989,JICA)	;	basic design, dam
Cross Sections, Dam	1/100	(1989,JICA)	;	basic design, dam

5-2-2. Geological and soil conditions (Materials)

Report of Bureau of Mines and Geo-sciences for Bohol island (1988)

F/S report for Bohol Irrigation Development Project, Phase II (1985)

Result of investigations on the Basic Design Study of the Project (1989)

5-2-3. Catchment area of the reservoir

The catchment area at the point of Capayas dam shall be considered with the existing Calanggaman Water Impounding under the Bureau of Soil, which is inside the Capayas area and releases water for outside the area. The total catchment area is broken down as follows:

Catchment of Calanggaman Impounding[1)]	:1.50 sq.km	
Others (at Capayas Dam point)	:13.1	Applied for the water balance study of the Project.
Total	:14.60	Applied for the flood estimation of dam design

Note[1)]; There are two dams in the Calanggaman area; namely, Calanggaman Water Impounding under Bureau of Soil (reconstructed in 1982) and the Calanggaman Dam under DPWH (presently under construction by NIA as contractor)

5-2-4. Size of Reservoir and Canal

The total reservoir capacity of Capayas Dam has been fixed as 2,300,000 cu.m and the effective reservoir capacity is 1,600,000 cu.m. The reservoir area and capacity curve is shown in Figure A-5-1 in Appendix. The size of Capayas Dam was, as proposed in the F/S of Bohol Irrigation Development Project Phase II, set up to supplement the capacity of Bayonan Dam as a regulating reservoir for the whole water balance of the Project.

The irrigable area of Capayas is 1,160 ha, of which only 750 ha of the currently proposed on-farm development area barely correspond with the water resource capacity of the catchment of the dam. Therefore, the size of water conveyance facilities from the dam shall be determined based on the development of Phase II. The maximum canal capacity has been fixed as 2.13 cu.m under the study.

5-2-5. Design Sediment

There are no data available on the sediment transported by Bayang river. According to the site investigation, the geographical condition for erosion is rather moderate and there occurs no land sliding. Most of the areas are uncultivated cogon land.

The geology of the area is composed of alternations of sandstone, siltstone and/or conglomerate in the reservoir portion and andesite in the upstream portion. Taking the above conditions into consideration, the unit of sediment amount will be 500 cu.m/sq.km/year and 100 years of sedimentation will be applied.

5-2-6. Seismic Factor for Structural Design (Design Seismic Force)

Since Bohol province is located in the Circum Pacific Earthquake Zone, it is necessary to consider carefully the seismic effect on the structures. Earthquakes around Bohol island may occur as a result of tectonic movement along the Visayas and Mindanao blocks. These blocks are large and therefore should be considered in designing the dam.

The JICA Study Team for Bohol Irrigation Development Project Phase II (1985) examined the design seismic force, and the result is shown in Table A-5-1 and Figures A-5-2 and A-5-3 in Appendix.

The procedure of the seismic analysis was as follows:

i) to collect the available data on earthquakes in the Philippines recorded by PAGASA (1907 ~ 1982).
Since Bohol island had no significant earthquake from 1982 to the present, the existing data will be used.

ii) to gather records of earthquakes (83 during 76 years) that occurred within a radius of about 300 km from the Bayongan dam site, which shall be the primal structure of BIDP Phase II (11.7 km south-west from Capayas damsite) and then to estimate the maximum seismic acceleration (Gal) on the damsite for each earthquake.

iii) to compile the following Gal numbers, and to plot them on a full-logarithm section-paper, a probable Gal number for any return-period can be obtained.

Return-period	Gal	Equivalent seismic force
10 years	39 cm/sec/sec	0.04
20	88	0.09
50	155	0.16
100	200	0.20

Since there is no particular criterion on design seismic force in the Philippines according to the NIA, a return-period of 100 years was adopted, and then the seismic force K=0.20 was applied for the design of Capayas dam.

5-2-7. Dam Design Flood

As mentioned in section 5-2-3, a catchment area of 14.6 sq.km shall be adopted in estimating the flood on the dam design. The Department of Public Works and Highway has provided a guide or criteria for structural design flood in the Philippines.

One of the four formulae in designing the catchment area has been recommended.

In applying this method for the dam project in the Bohol island, a detailed examination has been performed by JICA on the F/S of BIDP Phase II.

The result is shown in Appendix Table A-5-2 and summarized as follows:

i) Considering the scale of the dam and the development status of the downstream area, the DPWH's formula for "Rare" was adopted, therefore, the maximum flood discharge becomes 417 cu.m/sec, and the corresponding constant based on Creager's formula[1)] reaches C=77.

Note[1)]; Among several formulae of flood discharge in reference with catchment area, the Creager's formula is used worldwide, having the merit of setting an object in unrestricted ranking by using the constant C.

ii) By the Creager's formula and applying the constant C=75 which is rather appropriate for Capayas dam considering the project scale and its hydrological condition, the maximum flood discharge becomes 405 cu.m/sec. While in NIA's other existing dams with a similar scale to Capayas dam, those constants C which correspond to the Creager's formula are almost all less than the above figure.

iii) By the Rational Method and applying the probable rainfall for a return-period of 1000 years in Dagohoy station, the maximum flood discharge becomes 369 cu.m/sec, and the corresponding Creager's constant is C=68.

Dagohoy station which has the longest continuous south-west from Capayas damsite.

iv) By examining past significant floods, corresponding constants to the Creager's formula are as follows:

Name of flood	Date	C	
Typhoon Delilah	22 Nov,1964	41	(By survey of the flood
Typhoon Nitang	2 Sep,1984	26	marks at Loboc Hydro P. Station)

v) By analysing Probable Maximum Precipitation on the meteorophysical theory, the value of precipitation is far less than that of the 1000 years return-period mentioned in section (iii). There was insufficient data for this kind of analysis in Bohol island.

As a result of these examinations, the maximum amount computed under DPWH's formula as mentioned in section i) above shall be finally adopted.

5-3. Basic Plan

5-3-1. Land Use Plan

The total beneficial area of the Capayas Irrigation System as proposed in the BIDP-Phase II is 1,520 ha and categorized as follows:

Net irrigable area	:	1,160 ha
Net upland crop area	:	220 ha
Canal and roads	:	140 ha
Total beneficial area	:	1,520 ha

The Capayas Irrigation System was planned on the basis of receiving supplementary water from Bayongan Reservoir through main canal, in addition to its own catchment. The total irrigable area of Capayas Dam depending upon its catchment is 1,230 ha.

The Project Area has slightly undulating topography and the predominant soils belong to the Ubay Series. These soils consist of deposits derived from shale, sand stone and silt stone. The substrata contain gravels. The surface layer, 20-50 cm thick is a grayish brown color and clay - loam - sandy loam texture. These soils are acidic and have low fertility. The drainage is generally functioning and the soils quickly dry up when there is no rainfall.

At present, rice is cultivated under rainfed conditions in 330 ha of lowland along the stream. In addition, there are 260 ha of upland, but the major parts are covered by cogon grassland (Table 5-1). The land use plan in the Project Area was formulated based on the topographical and soil conditions as well as present land use.

The following points were considered in the land use planning;

i) The land with higher elevation than the irrigation canal was excluded from the beneficial area because the land cannot be irrigated by gravity.

ii) Existing paddy fields in the Project Area were included in the beneficial area as much as possible.

iii) Present upland or grassland which have less than 3% of slope and are suitable for paddy fields should be converted into paddy fields. In total, 430 ha of land (200 ha of upland and 230 ha of grassland) will be converted into paddy fields.

iv) On the land to be converted to paddy fields, 100% of rice cultivation in wet seasons and combination of rice and upland crops cultivation will be performed. Upland crops in the dry seasons such as mungo beans, maize, groundnuts and vegetables which have high marketability will be introduced. And since the water table is shallow and drainage is poor in the depression, the upland crops will be cultivated on the elevated land.

v) Class II land with 3-5% slope which is presently used for upland crops or grassland will be used for cassava and sweet potato cultivation under rainfed conditions. In the beneficial area, 140 ha of Class II land will be used as upland fields.

vi) Class III, IV and V land will not be used for cultivation but for grassland. This land will be used for soil conservation of hilly land, production of green manure and forage for livestock.

vii) Existing coconut trees around the houses will remain uncultivated.

viii) About 7-10% of the beneficial area will be used for canals and roads.

The Project Area was classified according to the land slope.

Class I land having a slope of less than 3% could be converted into paddy fields after land preparation. Classes II and III land having a slope of 3-5% will be used only for upland crops. Class IV land (slope 5-8%) and Class V land (slope more than 8%) are mainly grassland at present and will not be used for cultivation. These lands will remain as grassland for soil and water conservation purposes.

The land use plan in the Project Area is shown in Table 5-1. The net irrigable area in the Project Area is 750 ha.

Table 5-1. Present and Proposed Land Use

(Unit: ha)

Land Use	Present	Proposed					
		Paddy	Upland	Grassland	Coconuts	Others	Total
Existing Paddy	330	320	-	-	-	10	330
Upland							
Class I	220	200	-	-	-	20	220
Class II	40	-	40	-	-	-	40
Sub-total	260	200	40	0	0	20	260
Grassland							
Class I	260	230	-	-	-	30	260
Class II.III	110	-	100	-	-	10	110
Class IV	80	-	-	80	-	-	80
Class V	-	-	-	-	-	-	-
Sub-Total	450	230	100	80	0	40	450
Coconuts & House	170	0	0	0	170	0	170
Others	20	0	0	0	0	20	20
Total	1,230	750	140	80	170	90	1,230

5-3-2. Farming Plan

a) Outline

The net irrigable area is 750 ha, and paddy fields were considered the most suitable for the irrigable land. Rice will be cultivated in the entire 750 ha during wet seasons. In dry seasons, upland crops and vegetables will be cultivated in 160 - 240 ha depending upon the rainfall condition, while rice will be cultivated in 510 - 590 ha.

In drought years, irrigation water will be saved by increasing the upland crop area. Accordingly, double cropping (200% cropping intensity) will be attained in all the irrigable areas. In the area where irrigation water cannot be supplied, cassava, sweet potates, ubi and gabi will be cultivated under rainfed conditions (140 ha).

b) Farming Type

Considering the soil and drainage conditions in the Project Area, two farming types for irrigated agriculture are proposed. They are "rice-rice type" and "rice-upland crop type".

Rice-Rice Type

This farming type will be applied to paddy fields from the existing rainfed paddy fields along the creeks and lower portion of the present upland fields where the drainage is poor. Rice will be continuously cultivated in both wet and dry seasons. High yielding varieties (HYV) such as IR-66 will be cultivated and APC technology will be fully applied. This type will cover 430 ha, consisting of existing paddy fields (320 ha) and newly prepared paddy fields (110 ha).

Rice-Upland Crop Type

This farming type covering 320 ha will be applied to paddy fields from the relatively higher portion and present upland fields or grassland where the soils are medium texture and have a good drainage system. In principle, upland crops or vegetables will be cultivated in one dry season within a period of two years. In drought year, the area of upland crops will be increased in the dry seasons to save the irrigation water.

These two farming types will be distributed intricately in the Project Area depending upon the topography and soil conditions. In general, the ratio of cropped area of rice to upland crops/vegetables in the dry seasons is 8:2.

c) Crop Selection

The main crop in the Project Area will be rice due to the following:

i) The production of rice in Bohol Province and Central Visayas Region is lower than the demand so rice has good marketability.

ii) Rice is presently cultivated in the Project Area and the farmers are acquainted with its cultivation practices,

iii) Generally, the soils in the Project Area are more suitable for rice cultivation than upland crops. The soils are acidic and have sandy loam to clay texture. Accordingly, lime application and drainage improvement in acidic soil and poorly drained soil respectively are required for upland crops cultivation.

The rice yield is expected to be more than 4.0 tons/ha under proper cultivation practices according to the trials in the APC Farm.

Upland crops will be cultivated in dry seasons in a part of the paddy fields. The following four kinds of upland crops show promising results at the trials in the APC Farm.

Legumes

The typical legume in the region is mungbeans. Because legumes are in short supply and high marketability in the Province and the cultivation of leguminous crops make the soils fertile, leguminous crops will be cultivated in the dry seasons, after harvesting of wet-season rice.

Groundnuts

Presently, groundnuts production does not meet demand in the Province and has high marketability. Mix-cropping with maize or planting before wet-season rice will be introduced in the Project Area.

Maize

The supply of maize in the province is insufficient. Maize was selected as feed for livestock. The high yielding varieties such as IPB2 and DMR2 will be planted.

Vegetables

Most vegetables sold at Tagbilaran Market come from the neighboring provinces. Tomatoes, carrot, cabbage and water melon are recommended for cultivation by the APC.

Root Crops

There is a starch glucose factory in the Province and cassava is cultivated under rainfed conditions in the largest area following rice. For sweet potatoes, high yielding and high protein content varieties are recommended by the APC. The Province is noted for Ubi Kinapay (violet yam) which is also recommended by the APC.

(4) Proposed Cropping Pattern

The proposed cropping patterns by farm types are shown in Figure 5-2.

For the "rice-rice" type, seedlings are grown in the nursery at the beginning of the wet season (mid-May to late-June) and transplanted during the period from mid-June to late-July. Wet-season rice crops are harvested from mid-September to late-October. As dry season cropping, seedlings are grown from late-October to late-November and transplanted during the period from mid-November to late-December. Dry-season rice crops are harvested from late-February to late-March.

For the "rice-upland crop" type, the upland crops such as mungbeans, groundnuts, maize or vegetables are cultivated during one dry season within a period of two years.

Figure 5-1. Crop Calendar

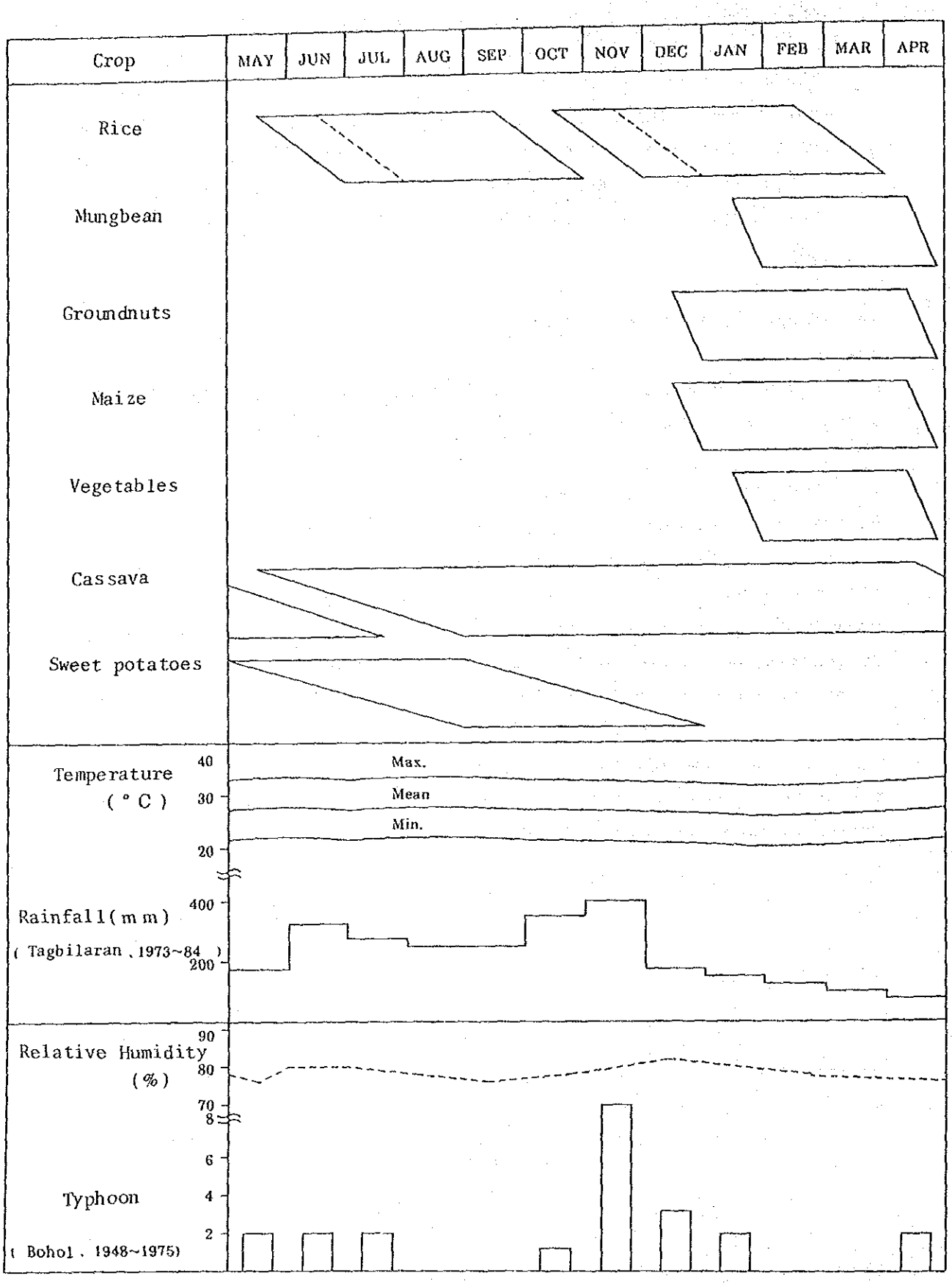
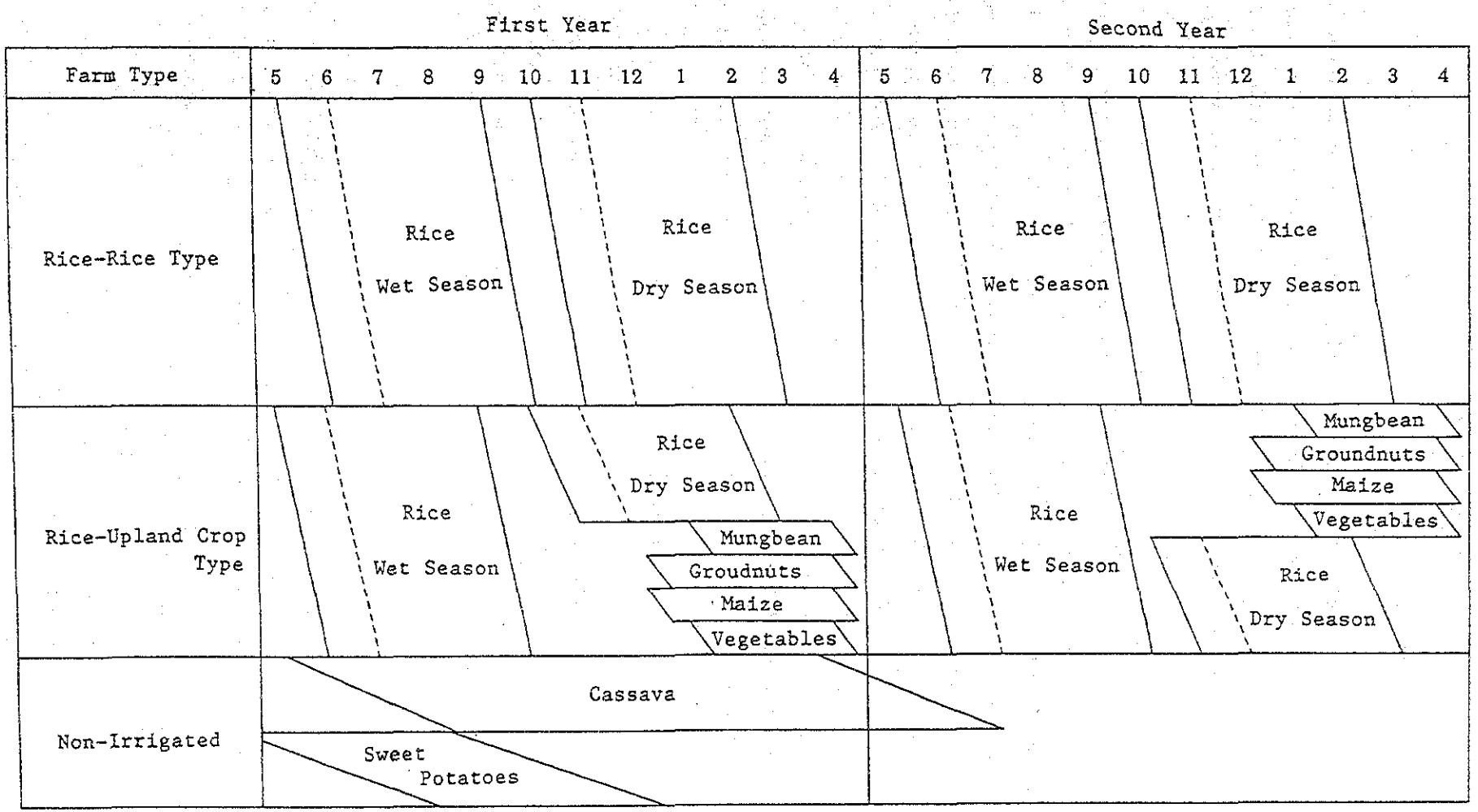


Figure 5-2. Cropping Pattern by Farm Types



d) Cultivation Practice

The cultivation technology which has been established by the APC will be widely applied in the Project Area. Rice seedlings will be grown in a water nursery. The minimum amount of agricultural chemicals should be used, and the residual toxicity will not affect the fisheries.

Because the soils in the Project Area are acidic, phosphate fertilizers will be effective for yield increase, therefore, application of guano (natural phosphorus fertilizer) will be introduced. Annual rice yields of more than 10 tons/ha have been recorded in the Carmen Pilot Farm of APC under the fertilization standards of 63-46-30 Kg-N.P.K/ha. For the farmers, proper water management and cultivation practices should be directed by the Department of Agriculture in cooperation with the APC. The extension worker organization in the Department of Agriculture consists of a provincial agricultural officer (PAO), a municipal agricultural officer (MAO) and the agricultural production technologists (APT). Tungro-tolerant varieties such as IR-66 are recommended in rice cultivation.

For cultivation of cassava, sweet potatoes and yam under rainfed conditions, soil management with rice straw mulching etc. will be applied. High yielding varieties will be used and the optimum amount of fertilizers will be applied.

e) Target Yield

The target yield of rice is expected to be 4.2 ton/ha in wet seasons and 4.5 ton/ha in dry seasons. For upland crops, the target yields are estimated as follows:

Mung beans	1.0	ton/ha
Groundnuts	1.7	"
Maize	2.7	"
Water melon	8.9	"

Under rainfed conditions, the target yield of both cassava and sweet potatoes are estimated at 14.2 tons/ha.

To achieve the target yield, a period of 5 years for existing paddy fields and 8 years for newly prepared paddy fields was planned. The annual crop production in the Project Area is shown below;

Table 5-2. Target Yield and Production

Crop	Cultivated Area	Yield	Production
	ha	ton/ha	ton
Rice (wet)	750	4.2	3,150
Rice (dry)	590	4.5	2,655
Total	1,340	-	5,805
Mungo bean	40	1.0	40
Groundnut	40	1.7	68
Maize	40	2.7	108
Vegetables	40	8.9	356
Total	160	-	-
Cassava	85	14.2	1,207
Sweet potatoes	55	10.8	594
Total	140	-	-

5-3-3. Irrigation and Drainage Plan

a) Irrigation Method

As shown in the previous section, the cropping pattern in the Project Area mainly consists of irrigated paddy (100% in the wet seasons and 78.7% in the dry seasons), and irrigated upland crops (21.3% in the dry seasons).

The irrigation plan was prepared based on the following criteria, taking into consideration the available water amount, cropping pattern and crop water requirement etc.

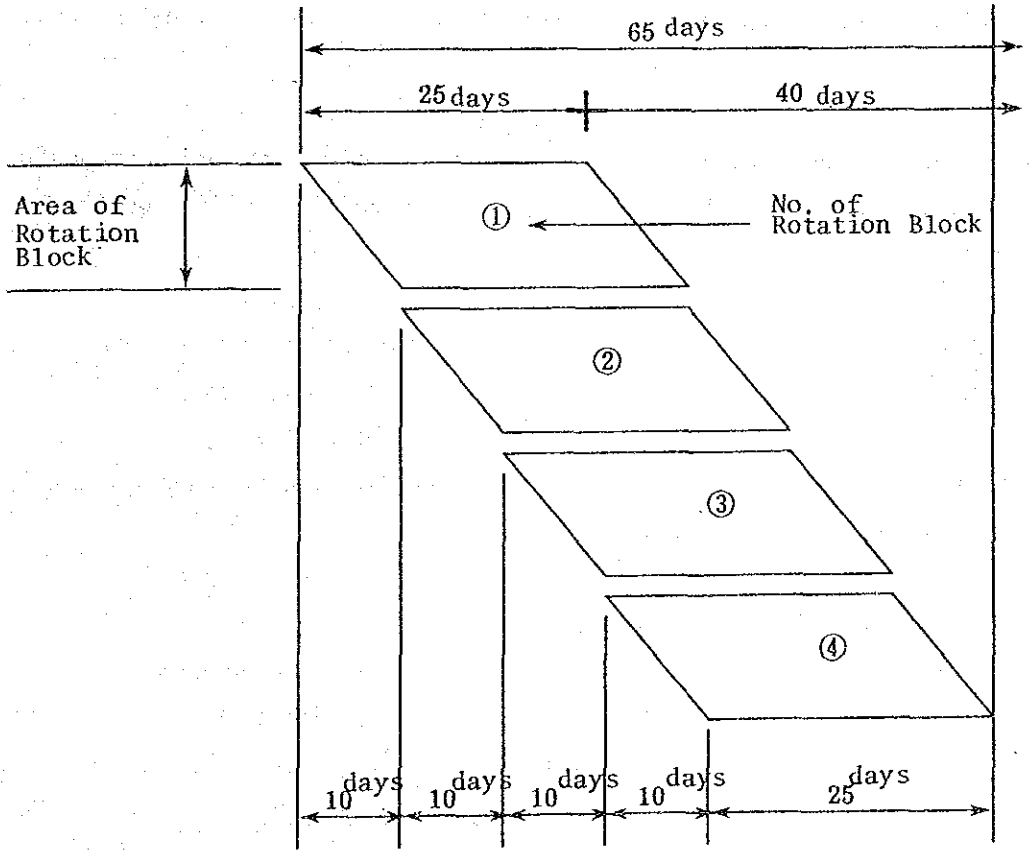
i) rotational application will be conducted during the puddling stage within the rotation block,

ii) simultaneous application will be carried out during the growing stage for all crops within the irrigation block. When the available water reduces, the irrigation method will be changed to the rotational application.

iii) irrigation for upland crops will be done by the same method as that for the paddy rice.

In the rotation block (25-46 ha), the duration of the puddling stage (plowing and puddling period before planting) is 25 days and 10 days-rotation. Number of days to complete the puddling works in whole Project Area is 65 days as shown below:

Figure 5-3 Puddling Stage



b) Water Requirement

The crop consumptive-use (ETPc) is obtained by multiplying the evapotranspiration and crop coefficient (Kc). As for crop coefficient of rice, the consumptive use of rice is considered to be equal to evaporation rate (ET) in the NIS. In this Basic Design, this assumption was applied. Since there was no evaporation data in Tagbilaran meteorological station, the ET/ETO ratio from the data of Negros Oriental was used in calculating similar to the F/S report on BIDP, Phase II (refer to APPENDIX Tables A-5-3, A-5-4, A-5-5, Figures A-5-4 and A-5-5).

Water requirement for rice was calculated for 10-day periods based on the cropping pattern taking into consideration the following (refer to F/S report).

* Field percolation rate was 1 mm/day during the entire growth period.

* Water requirement of puddling was 210 mm for the wet season and 170 mm for the dry season.

Table 5-3 Water Requirement for Puddling

(Unit: mm)

	Dry Season	Wet Season
First	114	132
Second	27	29
Third	33	45
Total	174 ≒170	203 ≒ 210

Similar to rice, the consumptive use of upland crops can be calculated by multiplying the evapotranspiration rate (ETo) and the crop coefficient (Kc). No data on the crop coefficient in the Project Area or neighboring areas were available; accordingly, the consumptive use of

upland crops were calculated for 10-day periods in accordance with FAO Irrigation and Drainage Paper No.24 (refer to APPENDIX Tables A-5-6 and A-5-7).

The results of calculation of water requirement are as follows (refer to APPENDIX Table A-5-8):

Table 5-4. Consumptive-Use of Crops

(Unit: mm)

Crop	Consumptive-Use
Rice	
Dry season	
Transplanted	711.6
Direct sown	775.5
Wet season	
Transplanted	789.3
Direct sown	847.8
Mungbean	260.8
Groundnut	314.1
Maize	361.3
Vegetables	251.6

c) Water Distribution Plan

i) Irrigation Efficiency

Considering the irrigation efficiency of the large-scale irrigation projects used by NIA, the irrigation efficiencies of the Project were determined at 55.8% for dry-season paddy, 53.6% for wet season paddy and 42.1% for upland crops as shown below.

Table 5-5. Irrigation Efficiency

(Unit: %)

	Rice		Upland Crops
	(Dry Season)	(Wet Season)	(Dry Season)
On-farm Application	73	70	55
Conveyance	85	85	85
Management	90	90	90
Overall	55.8	53.6	42.1

ii) Proposed Irrigation System

The proposed irrigable area is 750 ha in the Capayas Irrigation System (total area: 1,160 ha). The irrigation diagram between Capayas Irrigation System and the Project itself is shown in Figure 4-1. The Project Area is located at the upstream of the Capayas Irrigation System. In deciding the capacity of the irrigation canals, the irrigation canal networks were planned to have enough capacity if the Capayas Irrigation System will be expanded in the future. The irrigation system of the Capayas Irrigation System is shown in Figure 5-4.

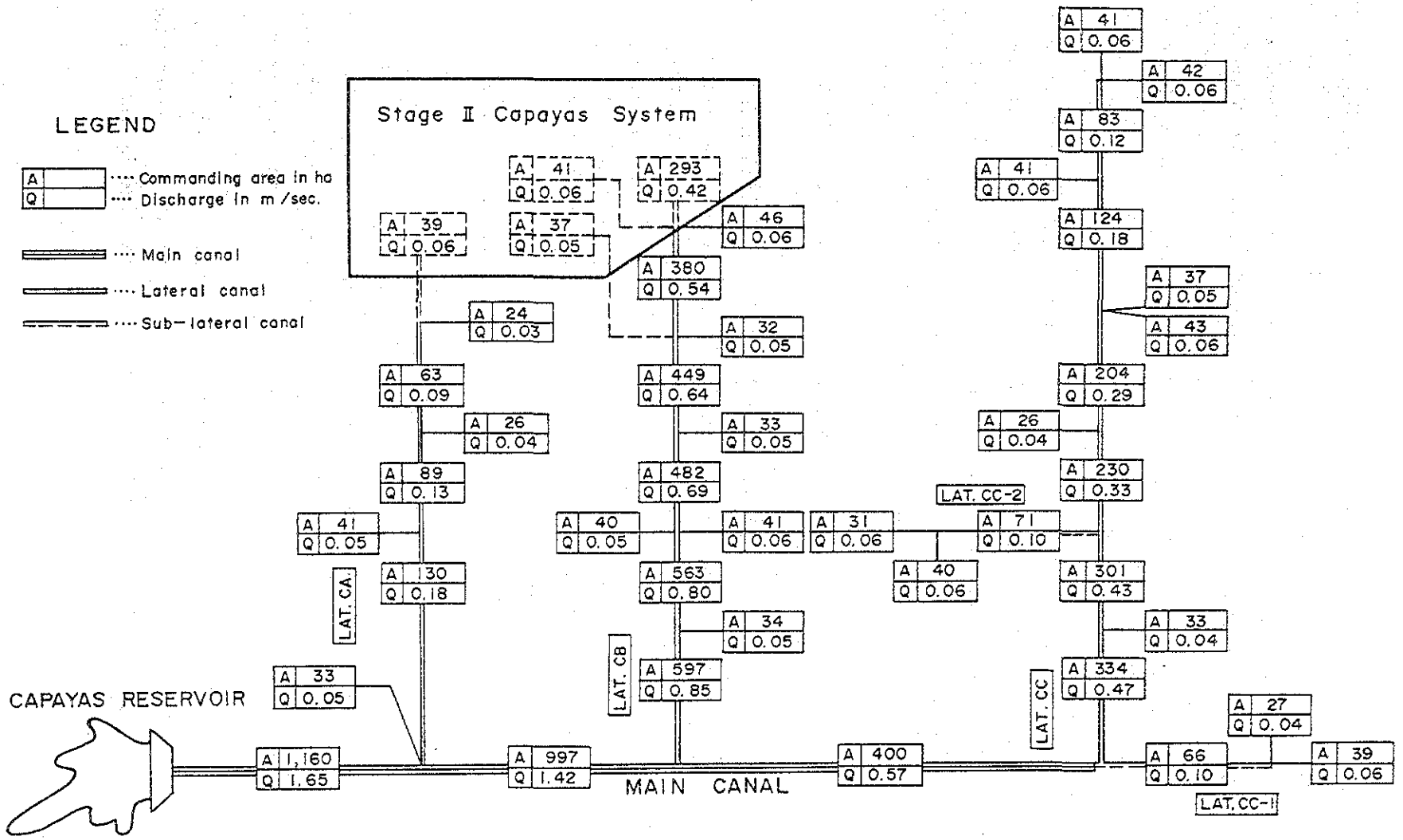
iii) Design Discharge of Irrigation Canals

The design discharge of main and lateral irrigation canals were calculated taking into consideration the irrigation of rice and upland crops.

Rice

The unit design discharge for rice of main and lateral irrigation canals were calculated for 10-day periods based on the cropping pattern, growth period, irrigation method, water requirement of rice by stages etc. (refer to APPENDIX Tables A-5-9 and A-5-10). The maximum water requirement occurs in the puddling stage of the wet season (maximum unit

FIGURE 5-4 IRRIGATION DIAGRAM OF CAPAYAS SYSTEM



water requirement in puddling stage is 1.83 l/sec/ha) but this stage is relatively short. Accordingly, the maximum value of growing stage, 1.422 l/sec/ha, is taken for unit design discharge of the canal and the necessary amount in puddling stage is covered by the freeboard of the canal.

Upland Crops

Quantity and intervals of irrigation for upland crops were determined after considering i) effective root zone, ii) moisture absorption pattern, iii) available moisture by layers within the effective root zone, and iv) total readily available moisture (TRAM). The results are as follows:

Table 5-6. Irrigation Plan of Upland Crops

Crops	TRAM	Max. Evapotranspiration	Irrigation intervals
	(mm)	(mm/day)	(days)
Mungbeans	57.6	4.9	11
Groundnuts	43.3	4.5	9
Maize	86.3	5.7	15
Vegetables	28.8	4.5	6
Average	-	4.9	

Irrigation intervals are different by crops, however, the interval of 7 days, which is generally applied, was taken because the unified irrigation interval is desirable from the point of water management.

In the rotation blocks where upland crops are irrigated, the irrigation quantity for the average of maximum evapotranspiration of upland crops was calculated below, assuming that the upland crops are similarly cultivated.

$$\frac{4.9 \text{ mm/day} \times 10^{-3} \times 1 \text{ ha} \times 10^{4} \times 10^{3}}{86{,}400 \times 0.421} = 1.347 \text{ lit/sec/ha}$$

The above figure is less than the maximum value in the growing stage of wet season paddy. Therefore, the unit design discharge calculated on the wet season paddy will be sufficient.

iv) Design Discharge of Terminal Facilities

The unit design discharge of the terminal facilities within rotation block was computed as follows, assuming that the first puddling water requirement of 132 mm would be supplied in 10 days in the wet season paddy:

$$\frac{13.2 \text{ mm/day} \times 10^{-3} \times 1 \text{ ha} \times 10^{4} \times 10^{3}}{86{,}400 \times 0.70} = 2.183 \text{ lit/sec/ha}$$

The design capacity of the diversion structure provided for each rotation block can be calculated by multiplying the unit discharge by the command area.

d) Drainage PLan

i) Projected Rainfall

There are three meteorological stations (Ubay Central, Ubay Bayang and Ubay Gabi) near the Project Area, and meteorological data in these stations can be used in analysing the projected rainfall. The rainfall records of these stations were corrected by using the rainfall data of Dagohoy, and the maximum daily rainfall at 1/5 and 1/10 probability were calculated as follows:

Table 5-7. Probability of Rainfall

(Unit: mm)

Station	Max. Daily Rainfall	
	(1/5)	(1/10)
Ubay Central	79.0	92.0
Ubay Bayang	93.0	102.3
Ubay Gabi	101.1	111.0

The Ubay Central Station is located at the border of the Project Area along the coastal area. This station was not considered representative. Therefore, the average rainfall of Ubay Bayang and Ubay Gabi are selected as the projected rainfall.

ii) Design Unit Drainage Discharge

The design unit drainage discharge was calculated at 5.61 l/sec/ha, considering the following points:

1) rice is cultivated in all the irrigable lands in wet seasons

2) allowable submerged days of rice is 2 days

3) standard year for drainage planning is 1/5 probability

4) projected rainfall is 97.1 mm

$$97.1 \times \frac{10^{-3} \times 1.0^{ha} \times 10^{4} \times 10^{3}}{2 \times 86,400} = 5.61 \text{ l/sec/ha}$$

FIGURE 5-5 DRAINAGE DIAGRAM