FEASIBILITY REPORT
ON
BOHOL INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT
IN
THE PHILIPPINES

(MAIN REPORT)

MAY 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

FORWORD

In response to the request of the Government of the Republic of the Philippines, the Government of Japan dispatched preliminary survey team for the Bohol Integrated Agricultural Development Project and the team carried out the general survey on the situation to outline the proposed project.

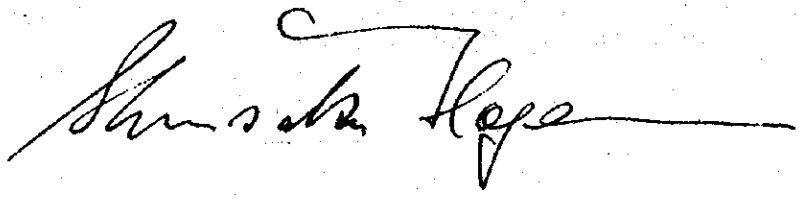
Continuously, the Government of Japan has decided to perform the feasibility study on the Project and dispatched the Bohol Integrated Agricultural Development Project Feasibility Study Team consisting of total 13 experts headed by Mr. Susumu TAKAMINE, Sanyu Consultants Inc.

Hereby is presented the final feasibility report of the above Project through the field surveys, the findings the team has attained and the exchange of views with the Philippine Government Officials concerned.

I firmly believe that this report greatly contributes to the social and economic development in the areas involved as well as promotion of freindship between the two countries.

I take this opportunity to express my hearty gratitude to the Government agencies concerned of the Philippines for their support and cooperation extended to the team.

May 1978



Shinsaku HOGEN
President,
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir:

We have the honor to submit herewith our report on the feasibility study for the Integrated Agricultural Development Project in the province of Bohol, Republic of the Philippines. The field survey was conducted for the period of three months from August 22 to November 26, 1977. This report has been prepared on the basis of various discussions held between the Philippine government agencies concerned and the Team.

The Team has completed the feasibility study for the Integrated Agricultural Development with the irrigation as the major component covering an area of about 7,300 hectares, located on the eastern central part of the Bohol province.

This project involves two remarkable features. One is that the agricultural development including land reclamation from grassland has been conducted in parallel with the development of water resources and in accordance with the Philippine Integrated Rural Development Projects. The other one is that based on the result of various alternative studies, the dam construction at the site of limestone formation (including hydropower) has been proposed as the first case in the country. Although the latter has still some technical problems to be further studied, we wish to state that this would be one of the best schemes in the area development.

This report comprises the following volumes:

Volume 1. Main Report
Volume 2. Appendix (I), (II)

We hope that this agricultural development project would be a good example and could contribute to the socio-economical development in the Philippines.

Finally, we take this opportunity to express our deep gratitude to the National Economic and Development Authority, National Irrigation Administration, Department of Agriculture Department of Public Highways, National Power Corporation, Department of Agrarian Reform, Bureau of Plant Industry, Fertilizer and Pesticide Authority, Ministry of Foreign Affaris (Japan), Embassy of Japan in the Philippines, Ministry of Agriculture and Forestry, Japan International Cooperation Agency and Advisory Group of the Project for their valuable assistance and cooperation extended to us throughout the survey period and for the compilation of this report.

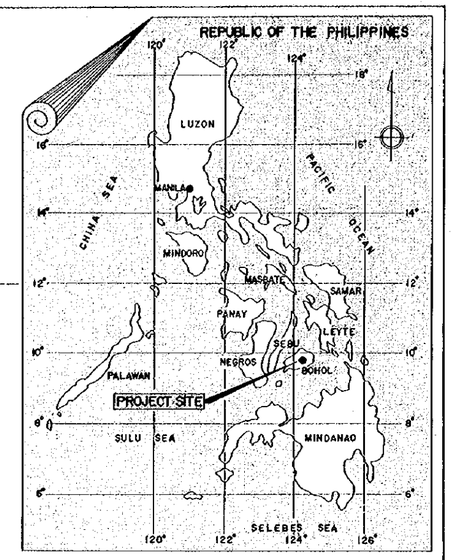
Respectifully yours,

May 1978

S. Takamine

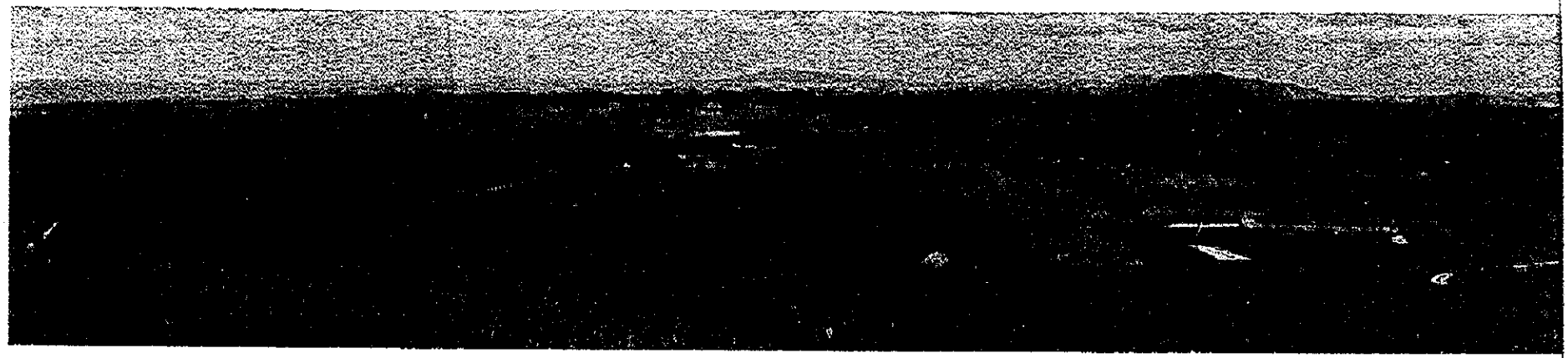
Susumu Takamine
Team Leader for the
Bohol Integrated Agricultural
Development Project

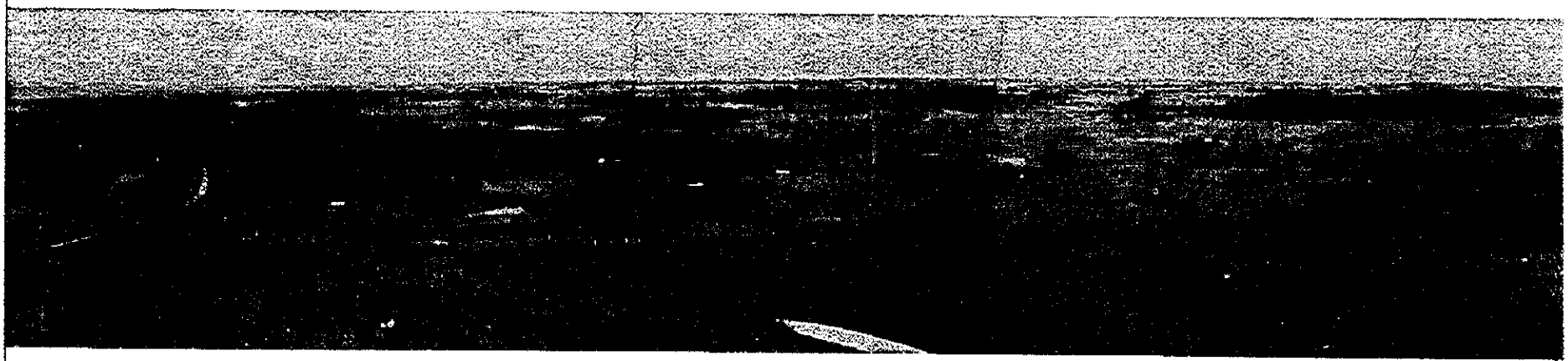
GENERAL PLAN OF BOHOL INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT



LEGEND

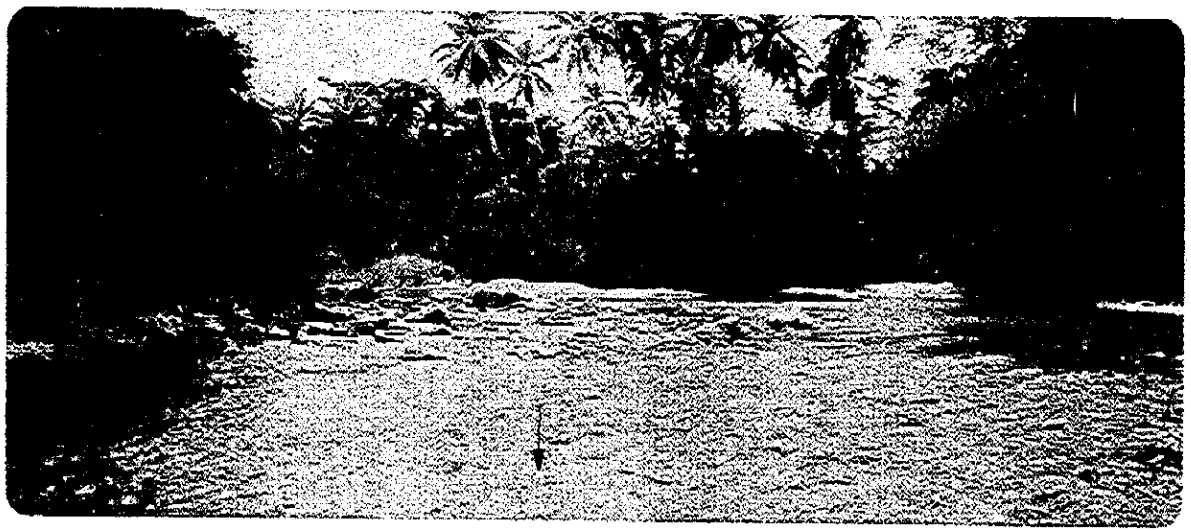
- Proposed Main Canal
- Proposed Lateral & Sub-lateral Canal
- Improvement of Main Drainage Canal
- Improvement of Lateral Drainage Canal
- Proposed Lateral Drainage Canal
- Proposed Service Road
- Improvement of Provincial or Barrio Road
- Proposed Dam
- Proposed Diversion Dam
- Proposed Power Plant



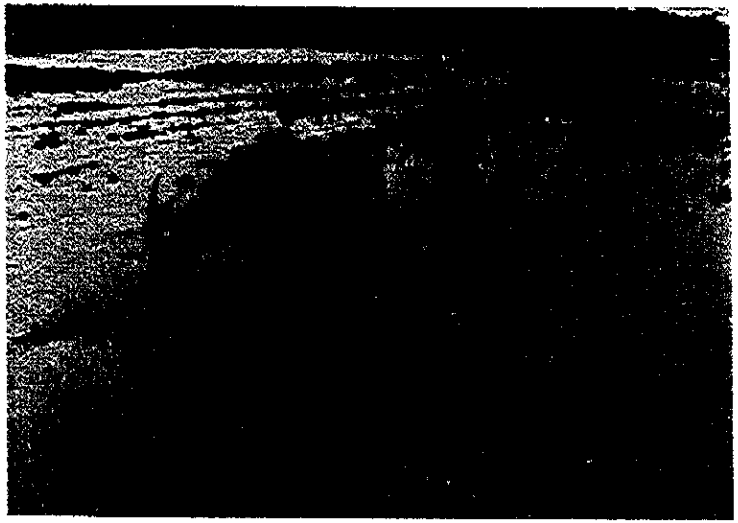


View of Lower Project Area

Proposed Site of Pamacsalan Dam



Upstream of Proposed Malinao Diversion Dam



Land Preparation by Carabao
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Transplanting of Paddy
at Communal Irrigation Area

Threshing of Paddy
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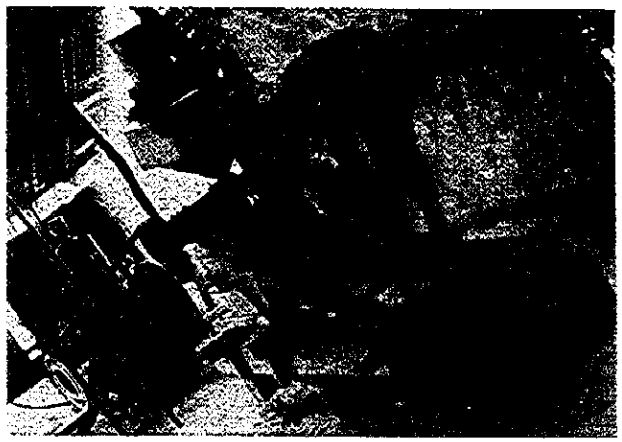
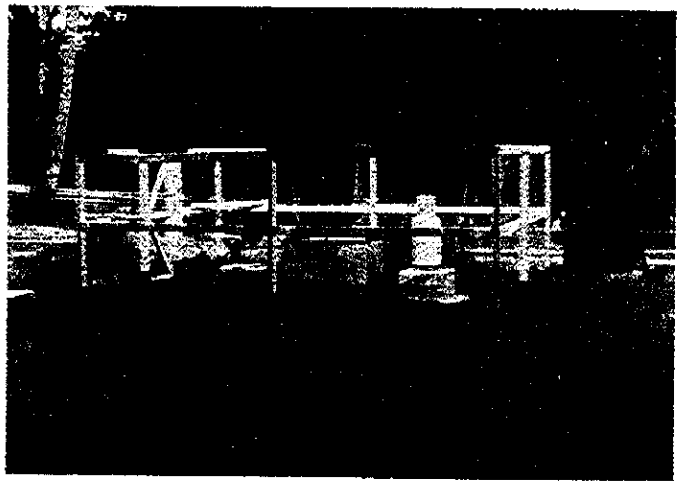


Small Scale Rice Mill
(Kiskisan Type) at Estaca



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CHAPTER IV. THE PROJECT

ABBREVIATIONS AND GLOSSARY

Agencies

ACA	:	Agricultural Credit Administration
ADB	:	Asian Development Bank
AMC	:	Area Marketing Cooperatives
BAEcon	:	Bureau of Agricultural Economics
BAEx	:	Bureau of Agricultural Extensions
NCSO	:	National Census and Statistics Office
BPI	:	Bureau of Plant Industry
BS	:	Bureau of Soils
BOHECO	:	Bohol Electric Cooperative
CCC-IRDP	:	Cabinet Coordinating Committee on Integrated Rural Development Project
BIADP	:	Bohol Integrated Agricultural Development Project
BPW	:	Bureau of Public Works
CB	:	Central Bank of the Philippines
DA	:	Department of Agriculture
DANR	:	Department of Agriculture and Natural Resources
DAR	:	Department of Agrarian Reform
DF	:	Department of Finance
DLGCD	:	Department of Local Governments and Community Development
DPH	:	Department of Public Highways
DPWTC	:	Department of Public Works, Transportation and Communication
FPA	:	Fertilizer and Pesticide Authority
FaCoMa	:	Farmers Cooperatives Marketing Association
IBRD	:	International Bank of Reconstruction and Development
IDA	:	International Development Association
IRDP	:	Integrated Rural Development Project
JICA	:	Japan International Cooperation Agency
NFAC	:	National Food and Agricultural Council
NEA	:	National Electrification Administration
NEDA	:	National Economic and Development Authority

Agencies

NGA	:	National Grains Authority
NIA	:	National Irrigation Administration
NPC	:	National Power Corporation
OECF	:	Overseas Economic Cooperation Fund
PNB	:	Philippine National Bank
PAGASA	:	Philippines Atomospheric Geophysical and Astronomical Services Administration
RB	:	Rural Bank
SN	:	Samahang Nayon
UPIP	:	University of the Philippines, Institute of Planning
USAID	:	United States Agency for International Development
USDIBR	:	United States Department of Interior, Bureau of Reclamation

Units of Measurement

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
sq.cm, cm^2	:	square centimeter
sq.m, m^2	:	square meter
sq.km, km^2	:	square kilometer
MSM, $10^6 m^2$	:	million square meter
ℓ, lit.	:	liter
cu.m, m^3	:	cubic meter
MCM, $10^6 m^3$	:	million cubic meter
lit/sec	:	liter per second
m/s	:	meter per second
PPM	:	part per million
g	:	gram
kg	:	kilogram
ton, m.t.	:	metric ton
cavan	:	50 kg
EL	:	elevation above mean sea level
MSL	:	mean sea level
FWL	:	full water level
HWL	:	high water level
LWL	:	low water level

Units of Measurement

sec.	:	second
minu.	:	minute
hr.	:	hour
min.	:	minimum
max.	:	maximum
%	:	percent
No.	:	number
°C	:	degree centigrade
°F	:	degree fahrenheit
Cl	:	chlorine
HP	:	horse power
ET	:	evapotranspiration
N	:	nitrogen
P	:	phosphorous
K	:	Potassium
HYV	:	high yielding variety
O & M	:	operation and maintenance
IRR	:	internal rate of return
B/C	:	benefit cost ratio
FY	:	fiscal year
₱	:	Pesos, ₱1 = approx. $0.133
$	:	Dollar, US$ = approx. ₱7.5

Conversion Factors

Unit	Comparison	English Equivalents
Units of Length		
Millimeter (mm)	0.001 meter	0.0394 inch
centimeter (cm)	0.01 meter	0.3937 inch
Meter (m)		3.2800 feet
Kilometer (km)	1,000 meters	0.6213 mile
Units of Area		
Square centimeter (cm^2)	0.0001 m^2	0.155 square inch
Square meter (m^2)		10.764 square feet
Hectare (ha)	10,000 m^2	2.471 acres
Square kilometer (km^2)	1,000,000 m^2	0.3861 square mile
Units of Volume		
Cubic centimeter (cm^3)		0.061 cubic inch
Liter (1,000 cm^3)	0.001 m^3	1.0567 quarts (liquid)
Cubic meter (cu.m)	1,000 liters	35.3145 cubic feet
Units of Weight		
Gram (g)		0.0353 ounce
Kilogram (kg)	1,000 grams	2.2046 pounds
Metric Ton (mt)	1,000 kg	2,204.6 pounds

Miscellaneous

1 cu.m per sec	= 1,000 liters per second (ℓ/s) = 35.3145 cu.ft per second (cfs) = 15,850 gallons per minute (gpm)
1 liter per second for 1 day	= 8.64 mm depth over one hectare
10 mm depth over 1 hectare	= 1.157 liters per second for 1 day = 3,532 cu.ft
1 horsepower (metric)	= 75 kg-m per second
1 horsepower (English)	= 550 ft-lb per second
1 cu.m of water per second under 1 m head	= 9.81 kw @100% efficiency
1 x 10^6 cu.m of water under 1 meter head	= 2,724 kwh @100% efficiency

Terminology

Arable land	:	Land identified in the land classification investigation as having adequate productivity to warrant consideration for irrigation
Bamboo	:	Bambusa Spinosa Roxb. a woody grass with a big hollow in the center of the internodes, growing in groves or clumps reaching a height of 25 meters or more.
Barrio	:	A political subdivision of a town.
Bolo	:	A large single-edged knife for a variety of uses like clearing the field, harvesting and household work
Calesa	:	A light, two-wheeled, horse-drawn vehicle commonly used to transport passengers of farm produce for short distances.
Carabao	:	The animal that most farmers used for plowing and other farm work. It is about the size of an ox and is similar to the water buffalo in other Asian countries.
Cogon	:	Imperata cylindrica (Linn.) Beauv. a coarse grass which usually covers idle lands or abandoned clearing
Fiesta	:	Spanish term for feast, celebrated pompously once a year to honor the patron saint.
Ganta	:	A common unit of volume for rice equivalent to 2.24 kilograms of milled rice.

Hectare	:	A metric measure containing 10,000 square meters equivalent to 2.471 acres.
IR-8, IR-5, IR-20:		High yielding rice varieties from the IRRI, Los Banos, Laguna, Philippines
Irrigable land	:	That portion of the arable land which is included in the irrigation service plan.
Monsoon	:	Periodic wind that blows from the sea to the continent and oppositely in winter.
Nipa	:	Nypa fruticans Wurmb. heavy-leafed type of reed used in thatching huts.
Palay	:	The rice plant which bears a staple cereal, or the cereal itself unhulled. Sometimes called rough rice.
Province	:	A political subdivision of a country comprising several towns.
Share tenancy	:	A practice where operators rent the land they work and pay as rent a share of the cash or crops grown.
Trade wind	:	One of the three Philippine air currents, comprising from a generally easternly direction reaching the islands during the period from February to April.
Typhoon	:	A storm or system of winds occurring in the Philippines and China Sea regions, known as hurricane in the West Indies and South Pacific, cyclone in the Indian Ocean.

BACKGROUND

SUMMARY, CONCLUSION AND RECOMMENDATION

BACKGROUND

1. Although agriculture is the biggest and the most important industry in the province of Bohol, unfavorable conditions surrounding current agriculture, such as irrigation facilities, farm roads and farming problems associated with cultivation, land ownership and marketing system may be considered as the reason. Therefore, the income of inhabitants in the Province is lower than the national average, and its population emigrate to Manila, Cebu and other cities. To improve these situations, the Government of Philippines designated this island as integrated development area concentrating on the development of agriculture.

2. The Bohol Integrated Rural Development Project (IRDP) was initiated by the Planning and Project Development Office of the Department of Public Works, Transportation and Communication in 1975, to expect the increase of agricultural Products, the significance of the strategy of the development and improvement of the people's living standard. A package of priority projects were identified, which included, among others, projects on irrigation, fishpond development, fishing port development, livestock farming, power plants, and development of agro-industrial estate. Irrigation components, however, was initiated by the National Irrigation Authority (NIA) under the jurisdiction of the National Economic and Development Authority (NEDA), and draft development plan was formulated in the northeast basin in the Province that would provide a balanced and speedy growth of the Province.

At present, the Bohol IRDP is in the priority list of integrated rural development projects approved by the Cabinet Coordinating Committee on Integrated Rural Development Project (CCC-IRDP).

3. Under the circumstances, the Government of the Philippines has made a request to the Government of Japan for technical cooperation to formulate the IRDP project in the Province, and in compliance with the request, the Japan International Cooperation Agency (JICA)

dispatched a preliminary survey team from 7th to 26th March, 1977 to make basic study on the feasibility of irrigation project particularly at the Wahig-Pamacsalan area, identified with the IRDP project for the province.

The main objective of the Team was to get full knowledge of the IRDP project with special emphasis on Wahig-Pamacsalan Irrigation Project (hereinafter so-called Integrated Agricultural Development Project), through the exchange of views with the Government officials and the survey.

4. As a result of the survey, the Team concluded that the Project is appropriate to let a feasibility survey team to conduct a study on the project. The reason why the Project Area has been selected is due to its geographical advantage which is recognized as an adjacent to development area in the central basin and on the east seacoast. Another major factor for its selection as a Project Area is the availability of potential water resources for irrigation.

SUMMARY, CONCLUSION AND RECOMMENDATION

A. SUMMARY

1. The Project Area, approximately 7,300 ha, is located about 60 km northeast of Tagbilaran city, the capital and commercial center of the Bohol Province (Bohol island is about 800 km southeast of Manila). The Area is situated within the five main municipalities of Pilar, Dagohoy, Sierra Bullones, San Miguel and Alicia. From Manila to Bohol island, it takes about one and a half hour by air and more than twenty-four hours by sea. There are national highways and provincial roads linking the Project Area with the provincial capital and other main municipalities.

The topography of the Project Area has considerable fluctuation with slope of three percent on average. The elevation of land ranges from about 240 m to 100 m above mean sea level.

2. The major rivers in the vicinity of the Project Area are the Wahig river and Pamacsalan river which is the tributary of the Wahig river. These rivers run through and meandering along the project boundary at western side. The maximum run-off discharge of the Wahig river is recorded at 1,100 cu.m/sec in November 1964 at the immediate downstream of the confluence of the two rivers, of which catchment area is 139 sq.km. The annual mean run-off discharge at the proposed site of Pamacsalan dam with catchment areas of 28 sq.km is 394 MCM, 291 MCM in the wet season and 103 MCM in the dry season.

3. The climate in the vicinity of Project Area as well as the watersheds of the Wahig and Pamacsalan rivers falls under the fourth type of climate in the Philippines. This type of climate is characterised by a rainfall which is evenly distributed throughout the year. The area is also outside the typhoon belt and is seldom affected by tropical cyclones. The average temperature throughout the year is 27.4°C at Tagbilaran City. The annual mean relative humidity is 82 percent at the said station.

The average annual rainfalls in the area are about 2,070 mm, of which 78 percent (1,620 mm) falls in the wet season from June to January. However, these rainfalls vary significantly by year, for instance 1,480 mm to 2,940 mm at Dagohoy rain gauge station.

4. The soils of the Project Area are mainly originated from sedimentary rock composed of shale, sandstone, siltstone, mudstone and marl, but the soils in southern part of the Project Area are developed under the influence of limestone which prevails in the catchment area of the proposed Pamacsalan reservoir. The limestone formation is apprarently sound, massive and less fluctuation, however, it may be pervious. On the other hand, the alternation of shale and sandstone is generally impervious and soft.

Under these conditions, all of these soils are considered to have good potencials capable of producing. The betterment of paddy cultivation practices accompanied by application of fertilizer and organic matter for soil amendment and construction of on-farm facilities will work out the potentiality under the blessed natural conditions.

5. The population density of the province of Bohol is about 180 persons per sq.km and that of the five municipalities related to the Project Area, namely, Pilar, Dagohoy, Sierra Bullones, San Miguel and Alicia, is about 140 persons per sq.km in 1975. Under the circumstance, it could be said that the Project Area and its neighborhood have been left behind the progress up to now. The major constraints for development are lack of irrigation water, infrastructural facilities such as irrigation and drainage facilities including those of on-farm level.

6. A national highway of asphalt, cement or gravel pavement provides all weather access to the municipalities from Tagbilaran city. Two unpaved provincial roads branching off from the national highway traverse the greater part of the Project Area, and the barrio roads branching off from the above-mentioned two types of road are for the transportation of

the barrio level. However, all of these roads except the national highway are dry-weather road, consequently, the transportation of living materials, agricultural inputs and outputs as well as the communication between barrios is difficult in the wet season due to poor road networks condition.

7. Total number of farmers in the Project Area is about 12,200 persons, which is equivalent to 57 percent of the total population of about 21,300 persons. These farmers' households are scattered in a group of two or three households everywhere or along the road. And, they are suffering from no lighting and inadequate drinking water supply in their daily living. There is no provision of electric facilities in the Project Area, except a few owned-generating plants, thus allowing almost all inhabitants to use kerosene lamp.

8. The Project Area of 7,300 ha can be divided into two areas from its topographic viewpoint, upper and lower areas. Regarding the land use in these areas, the cultivated areas are about 2,230 ha (30 percent of the total Project Area), that is, about 460 ha irrigated paddy field, 1,060 ha of rainfed paddy field, 290 ha upland rice field and 420 ha upland crops such as coconut and banana. The remaining areas of about 5,070 ha are left as grassland (cogon lands) and others with relatively hilly rolling terrain, especially in the lower area. The rainfed paddies are mainly developed in the lower portions between rolling highlands in the lower area under an even distribution of rainfall throughout the year.

9. There is no systematic irrigation and drainage facilities in the Project Area except the limited small portions of about 460 ha which are served by the communal irrigation, privately-owned pump irrigation and FSDC irrigation systems. The communal irrigation areas are located only in the upper area along Wahig and Pamacsalan rivers and these areas are about 370 ha served by water intake facilities made of concrete or coble stone on the river course. The pump irrigation is privately carried out along the Wahig and Pamacsalan rivers in order to irrigate the relatively highland. The pump irrigation areas are about 90 ha consisting of unit irrigation areas of three to twelve hectares. The FSDC

has a plan to irrigate the area of about 100 ha by pump in Barrio Dagohoy although this scheme is under construction. In these paddy fields, double cropping of rice is carried out through the year.

10. The most serious constraint to agriculture in the Project Area and its vicinity is shortage of stable irrigation water to be expected through the year and the absence of irrigation and drainage facilities including those of the on-farm level, although the farmers have strong eagerness to cultivate crops. Under the circumstances, the water resources development as well as the provision of systematized irrigation and drainage systems including those of on-farm level are prerequisite in order to materialize the increase of products through the double cropping with high yield variety. As a part of the water resources development in watershed, Reforestation Office in Dagohoy has a plan of reforestation at the upstream of Wahig and Pamacsalan rivers since 1977.

11. The most extensive cropping pattern has been practiced in the present paddy field; a) the irrigated paddy fields are cultivated with high yield varieties twice a year, that is the wet season cropping from June to October and the dry season cropping from December to April; b) the cropping schedule for the rainfed paddy fields vary every year due to unstable rainfall, which make the lag period last for about two months, but cropping is practiced twice a year; c) traditional rice variety called "Lubang" is mostly seeded directly to upland rice fields once a year. An average yield of irrigated, rainfed, and upland rice is 2.3, 1.6 and 0.8 tons per hectare respectively, which is equivalent to a weighted average yield of paddy of 1.7 tons per hectare. The cropping intensity is estimated at 174 percent.

12. The average farm size in the Project Area is estimated at 1.5 ha per household, however, 45 percent of the total areas are possessed by about seven percent of total farm households, of which farm size is about 11 hectares per household. The grasslands of about 4,700 ha exist in the Project Area and an average size of grassland per household is 4.8 ha. But about 64 percent of these grasslands are possessed by the land-owner

having more than 7 hectares (an average size of grassland per houshold is 13.8 ha). These land-owners would become farmer after the completion of the Project.

Regarding the land tenure system in the province of Bohol, the Issued Land Transfer Certificates to the tenants have been completed in 12 municipalities out of 48 municipalities in the Province. In these areas, Pilar, Dagohoy and San Miguel concerned to the Project and Carmen, Ubay, Candijan and Guindulmun adjacent to the Project Area are included. The percentage of cropping area by land-owner and share-tenant represents 46 and 44 percent respectively. The most frequent sharing ratio between land-owner and share-tenant is 30 to 70 percent, according to the agro-economic survey conducted by NIA in 1977.

13. The networks of agricultural extension services in the Project Area and its vicinity have already been set up under the responsibility of the Government agencies concerned such as the BPI, BAEx, DAR, DLGCD and NGA. The supplies of input materials such as seeds, fertilizers, agricultural chemicals and farm machineries and credit have been carried out based upon the programs of Masagana 99 and Masagana Maisan through Irrigators' Association, Farmers Association, Samahang Nayon and Kilusang Bayan under the cooperation of BPI, BAEx, DAR, and DLGCD. Furthermore, the processing and marketing of products have been made by the guidance of the NGA. At present most of the farmers in the areas are not yet eligible to these programs due to the shortage of funds.

14. Power supply networks in Bohol had already been established in the 17 municipalities, especially the western part of the Province, by the NPC, NEA and HOHECO. The present power stations inclusive of those under construction are Laboc Hydro-power, Tagbilaran Electric Cooperative, Tagbilaran Diesel and Tubigon Diesel, and their total installed capacity is 16.6 MW. The electric power supply networks in the vicinity of the Project are not yet provided, however, it is said that these areas are to be served by the power supply plan of Tagbilaran Diesel Power Station in the near future, which is presently under construction.

15. The Project aims to increase agricultural production, create employment opportunities and improve environment. In order to achieve these objectives and to attain quick yield benefit in the whole Project Area, the following components should be envisaged by phasing manner.

Civil Works

i) Irrigation and Drainage: The construction of dam, diversion dam and irrigation and drainage canals.

ii) On-farm development: The construction of on-farm roads, farm ditch and farm drain.

iii) Roads: The construction of road networks including rehabilitation of the existing provincial roads, etc.

iv) Hydropower: The generating mini-hydro-electric power for rural electrification.

Agricultural Development

v) Irrigated agriculture: The introduction of new agricultural techniques with double cropping of transplanted paddy of high yield varieties under well-controlled water management.

vi) Supporting services: The provision of necessary extension and training services, strengthening of input supply, credit, marketing and agricultural processing.

vii) Institutional arrangement: The establishment of farmers organization including those for operation and maintenance and the agricultural cooperatives.

16. According to the topographical and geological condition in the river basin as the water resource development, three potential dam sites at

Pamacsalan, Wahig and Bagunan rivers have been selected to have storage functions. Also in order to use the limited water resource as much as possible, a diversion dam at the confluence of Wahig and Pamacsalan rivers was proposed and named Malinao diversion dam. It would also be possible to have a storage function at the Malinao diversion dam so as to have a function of after-bay to regulate the excess water of peak power generation and reuse of the return flow from the upper area.

17. The alternative studies have been categorized into three cases of single reservoir plan, multi-reservoir plan and trans-basin plan in view of the disposition of reservoirs. According to the project purposes, the alternatives have been grouped into irrigation only and irrigation with hydro-power generation. Consequently, by combination of the proposed reservoirs and their purposes, 14 cases are selected to find the optimal scale of development among them.

18. In advance to start the alternative studies, following three initial studies have been performed. (i) optimization on the cropping calendar was performed and the cropping calendar of 50-day land soaking period starting from last 10-day in May was selected to adopt the cropping calender for the Project. (ii) Trans-basin discharge from the Wahig reservoir was anticipated to find the most suitable reservoir capacity of Wahig reservoir and to estimate the dependable trans-basin discharge through a trans-basin tunnel to the Pamacsalan reservoir. The storage capacity of the Wahig reservoir was decided at 1.88 million cubic meters in the effective storage capacity. As the sediment storage for 100-year was estimated at 0.92 MCM, so that the total storage capacity becomes 2.8 MCM. (iii) The storage capacity of Malinao diversion dam was decided at 3.3 MCM in effective storage, considering the topographical condition, submerged area of existing communal irrigation area and the required effective function of after-bay.

19. As for the hydro-power generation, a firm power generation system was adopted in case of without after-bay. On the other hand, when after-bay is available in the downstream of the main reservoir, such as Malinao

diversion dam or Bagunan reservoir, a firm peak power generation of at least six hours in a day was adopted to find the dependable generation capacity and annual energy production.

20. The required storage capacity was decided on the basis of the operation rules and the satisfying the 10-year return period of drought condition within three-year carry over condition. According to the reservoir water operation studies as well as the cost and benefit analysis, the internal rate of return and construction cost per hectare were analyzed in each case. The Case II-B-2 which is the combination of Pamacsalan reservoir and Malinao diversion dam with a storage function could achieve the total potential irrigation area of 5,320 ha to supply sufficient irrigation water as well as the hydro-power generation of 1,700 kilowatt in installed capacity. The Case II-B-2 indicates the internal rate of return as well as the construction cost per hectare are the best figures among all of the 14 alternatives. Accordingly, the Case II-B-2 was selected as the optimal scale of development to be proposed for the implementation of the project.

21. The required storage capacity of the Pamacsalan reservoir is 30.18 MCM in effective storage out of which 28.38 MCM is required for irrigation and 1.8 MCM for hydro-power generation. As the sediment storage is estimated at 1.12 MCM for 100-year, the total storage capacity amounts to 31.30 MCM. The full water elevation is EL 248.5 and the dam crest elevation is EL 251.5 so that the height of dam from the foundation becomes 67.5 m.

22. The required storage capacity for the Malinao diversion dam is 3.365 MCM in the effective storage out of which 3.30 MCM requires for irrigation and in order to regulate the daily peak power generation, 0.065 MCM was added to the capacity. As the Malinao diversion dam has been design to install three gates for the whole width of the river course, the sedimentation in the upstream can be flushed out to the downstream, so that the sediment storage was not considered. The full water surface elevation is EL 152.0 m and the dam crest

elevation is EL 154.5 m so the height of dam becomes 24.5 meters from the foundation.

23. The irrigation area for lower area is 4,800 ha served by the Malinao diversion dam and the Pamacsalan upper area is 120 ha. As for the Wahig upper area, the irrigation area cannot be supplied with irrigation water from the reservoir. However, the Wahig upper area has been included in the project area as a rehabilitation area of the existing communal system. The irrigation acreage has been decided at 256 ha and 400 ha for the first and second crop, respectively with the return period of 5-year drought condition, since the area could not served by the reservoir. In total, 5,320 ha has been decided as the project area to be supplied irrigation water.

24. The installed capacity of hydro-power generation has been decided at 1,700 KW with two units of 850 KW. The dependable capacity becomes 1,225 KW in average for 20-year and firm peak power of 850 KW was guaranteed to generate throughout the year. The annual energy production amounts 5,175 MWH in average so that the plant factor becomes 36.2 percent.

25. The average annual irrigation water demand amounts 54.7 MCM (1,110.9 mm/year) and exclusive use of hydro-power amounts 9.7 MCM/year. The average total demand, therefore, is 64.3 MCM/year. On the other hand, in average, 59.3 percent of the total demand was supplied from the Malinao diversion dam and 40.1 percent of that has been released from the Pamacsalan reservoir. The water shortage has occurred only one year in 1968-69 for 7.8 MCM during 20-year period which corresponds to 0.6 percent of the total demand in average. The water supply capacity at the Malinao diversion dam from the stored water shows that the 3.1 times/year of the storage capacity in average has been repeatedly used in 1967-1968. In the maximum condition, 5.3 times/year of the storage capacity is repeatedly used. While in the Pamacsalan reservoir, the repeated use of the stored water becomes only 0.4 times/year in average and 1.2 times/year in the maximum condition in 1965-1966.

26. As for the utilization of natural river flow, 63.8 percent of the river flow was utilized for irrigation and hydro-power at the Pamacsalan reservoir. While at the Malinao diversion dam site, 57.7 percent of the river flow has been utilized for irrigation. In other words, 42.3 percent of the river flow which amount is 46.8 MCM/year was not used for the project and overflowed to the downstream. Even in the droughtest year in 1968-69, 17.8 MCM has still overflowed to the downstream without utilization of the project. Therefore, the potentiality of the water resources will be still possible to develop the other project.

27. Irrigation water requirement to meet the proposed cultivation area of 5,320 ha is calculated by using the climatological data based upon the proposed cropping pattern. The maximum irrigation water requirement to serve the lower area of 4,800 ha is estimated at 6.79 cu.m/sec with a unit water requirement of 1.414 lit/sec/ha, which is diverted from the proposed Malinao diversion dam. The Malinao diversion dam having the storage capacity of about 3.4 MCM at the normal water surface of EL 152.0 m above mean sea level is planned to be constructed at the immediate downstream of the confluence of the Wahig and Pamacsalan rivers. In order to raise the water level up to W.L 152.0 m, two roller gates (flood gate), 7 m high and 13 m wide, and one roller gate (flash gate), 10 m high and 13 m wide, are to be installed on the overflow section. For the upper area of 520 ha, two diversion dams are planned to be constructed at the upstream of Wahig and Pamacsalan rivers.

Rotational irrigation has been recommended to be adopted in the Project Area. One rotational area is decided at abou6 25 ha on average although the area will vary depending upon the topographic conditions. Water management in one rotational area served by one turn-out is planned to be carried out within 25 days with five days rotation for land soaking and preparation works.

28. Earth irrigation canals with trapezoidal cross-section are planned to be provided to order to convey the irrigation water, of which layout

of the canal networks were plotted on the topographic map of 1:4,000 in scale so as to expect a maximum beneficial area at a reasonable cost. The proposed total lengths of the main, lateral and sub-lateral irrigation canals for the whole Project Area are estimated at about 131 km, which is equivalent to the canal intensity of 24.7 m/ha.

Similar to the irrigation canal, the plan of the proposed canal alignment for drainage canals, of which cross-section is also trapezoid without lining, was made based on the map of 1:4,000 in scale. These drainage canals are planned to be located at the lower portions between rolling highlands which are at present utilized for rainfed paddy fields with a function of drainage canal. Design discharge of the drainage canals is 6.60 lit/sec/ha. The proposed total lengths of the main and lateral canals are estimated at about 98 km, and their intensities are 18.0 m/ha. In accordance with the provision of irrigation and drainage canal, the related facilities such as regulating structures, protection structures, drops and so forth are also planned.

29. The road networks will be established in the Project as a means of facilitating operation and maintenance of irrigation and drainage facilities and transporting product as well as communication between the barrios. Proposed roads including the improvement of existing roads are classified into four types: provincial road, service and access roads, barrio roads and on-farm roads. All of these roads except the on-farm roads which belongs to on-farm facilities are planned to be paved by base core materials with a width of 6.0 m and 3.0 m, and their proposed length is about 118 km for the whole Project Area, with the road intensity of 21.8 m/ha.

30. The farm land development consisting of land terracing and levelling and the provision of terminal on-farm facilities such as farm ditch, farm drain and farm road are essential works to execute the irrigated agriculture including farm mechanization. Study on land parcelling plan was made in the two selected smaple areas. Regarding the water supply systems, the following two methods are planned:

Case A: main farm ditch is aligned across the contour lines, so that supplementary farm ditches will be located along the contour line.

Case B: main farm ditch is arranged along the contour line, thus locating the supplementary farm ditches across the contour lines.

These two plans are to be applied to the site based upon the topographic conditions in the Project Area. The size of farm plot in any case is planned to be about 0.3 ha in maximum, length of terrace of 100 m and width of ferrace of 30 m in maximum, and the length of terrace will be located along the contour line. The major on-farm facilities is main and supplementary farm ditches, farm road, turnout, diversion box end check, farm road crossing, drops and so forth. The design capacity of main and supplementary farm ditches in one rotational area is 34.8 lit/sec., equivalent to 1.39 lit/sec/ha.

31. As for the hydro-power scheme, the three case studies were made, namely, a) mini-hydropower for the Project Area for firm power generation with 24 operation hours, 600 KW x 2 units, b) firm peak power with 6 to 24 operation hours, 850 KW x 2 units and c) peak power during irrigation period, 1,700 KW x 1 unit. From the results of careful study on technical and economical viewpoints and discussion with government authorities concerned, the case b) is recommended to be the final confiruation of the Project scheme. The scale of the proposed power plant is as follows:

Maximum discharge:	1.5 cu.m/sec/unit
Maximum head:	73.5 m
Turbine output:	900 KW (2 units)
Generated capacity:	850 KW/unit
Plant factor:	36%
Annual energy production:	5,175 MWH

Power plant will be constructed on the right side of the downstream of the dam and 69 KV transmission line will be connected from the power plant to the NPC sub-station to be provided in Carmen City.

32. After implementation of the Project, the area of 5,320 ha, which is equivalent to 73 percent of the total Project Area will be developed into irrigated cultivation areas by gravity irrigation. These areas are classified into about 3,320 ha of 2nd class land (2R) and about 2,000 ha of 3rd class land (3R) in terms of soil suitability for paddy cultivation. Out of the area of 5,320 ha, about 3,800 ha is the area to be newly reclaimed from upland fields and grasslands. About 190 ha of upland fields which is presently utilized for the cultivation of perennial crops such as coconut and banana will be left the same.

33. The whole reclaimed-paddy fields will be used for paddy cultivation with high yield varieties in the Project, because paddy is the most suitable crops and farmers have eager intention to paddy cultivation. Double cropping of paddy will be fully introduced in about 5,180 ha of the irrigation area out of the 5,320 ha. However, for the remaining area of about 140 ha, which is located in the upper area served by Wahig diversion dam, irrigation water supply will be made only for the dry season paddy.

An annual total production of paddy is estimated at about 42,200 tons, of which an average yield is 3.8 ton/ha for the wet season paddy and 4.2 tons for the dry season paddy, and about 36,700 tons of paddy are to be increased in comparison with those of the present one.

The cropping intensity of the proposed cropping pattern amounts to 194 percent, including the cropping intensity of about 190 ha of upland fields which will be used for the cultivation of perennial crops such as coconut and banana without irrigation.

34. The present traditional farm operation systems of paddy cultivation will be converted into the combined systems of the traditional

farming and minimum mechanized farming in the Project, under the well-controlled water management and more intensive farming in relatively big farm plot. As a result, an available farm labor force in the Project will be balanced with total farm labor requirement except during the busy season such as transplanting. The maximum labor shortage during the busy season is about 31 percent of the available labor force, which will be easily converted by hired labor in the Project Area and its vicinity.

35. In the agri-institutional and supporting services aspects, it is considered highly recommendable to organized the farmers' organization such as Irrigators' Group and Irrigators' Association under the Wahig-Pamacsalan River Irrigation Office (W-PRIO) to be newly organized. Irrigators' Group consisting of about 25 to 30 farm households are for water users' unit in the area of two rotation block of about 50 ha, and about four or five Irrigators' Groups are integrated as sone Irrigators' Association, which covers the area of about 200 to 300 ha and consists of about 80 to 120 farm households.

The farmers' organization is to function for water management, operation and maintenance of on-farm facilities, farm management and supporting services such as agricultural input supply of necessary materials, credit, marketing and processing under the assistance of Kilusang Bayan and Samahang Nayon. At the same time, agricultural extension services are to be strengthened by newly established Irrigators' Association through aforesaid cooperatives such as Kilusang Bayan and Samahang Nayon.

All of the above-stated activities are to be well integrated, otherwise the production increase which is the ultimate target of the Project would not be attained. For the realization of the aforesaid integration, it is considered to be essential to organize the Joint Steering Committee at the national level to secure smooth communication and execution of all matters concerned.

36. The construction works of the Project will be commenced in FY 1981 after completing the final design in FY 1980. The total construction period of the project is seven years from FY 1979 to FY 1985, including final design. In planning the implementation schedule, particular attention will be paid to attain quick benefits from the Project. From this standpoint, Malinao diversion dam will be first constructed in FY 1981 in one year advance, prior to the commencement of construction of Pamacsalan dam. However, the provision of the reservoir will steadily promote the benefits in the Project, so that the construction of reservoir shall be recommended as early as possible to attain the quick benefits of the whole Project Area.

37. Though this scheme is an integrated project composing of irrigation, agriculture, road and hydropower components, NIA will be the Executing Agency of the Project. This agency will be responsible for the design, supervision and construction of the project works, and NEDA will coordinate the activities of all the relevant government agencies and the regional administration in connection with the implementation of the Project. The Bohol Integrated Agricultural Development Project (BIADP) Office will be organized as a government's force for construction and on-site coordination of the Project. This Office will be headed by a Project Director appointed by the Cabinet Coordinator of the BIADP, and will be the direct executing agency. The entire project works, upon completion of the Project, will be turned over to the NIA Regional Office No.VII, and the responsibility of operation and maintenance of all irrigation and drainage facilities will fall under the Wahig-Pamacsalan River Irrigation System Office (W-PRISO), which will be newly organized.

38. The total investment cost, including the price escalation of eight percent during the construction period is estimated at about US$43.6 million, of which US$25.2 million will be foreign currency component and an equivalent of US$18.4 million will be local currency component. From the result of the estimation, the Project cost per hectare is estimated at US$4,480 as a whole.

39. The project economic justification, in general, is evaluated by using direct benefit and cost which are measured in monetary terms. From the economic viewpoint, these procedures are expressed in the incremental benefit and cost which will be created by the difference between those of with project and without project. Direct benefits in the Project consist of agricultural benefit and hydropower benefit. The former is expressed in annual incremental net production value and the latter is estimated by applying the standard capacity-energy approach.

40. Annual gross cropping areas of paddy in the Project would be increased from about 1,360 ha in the year of 1982 to about 10,500 ha of the full development area in 1985, which will be reclaimed based on on-farm development schedule. Out of the 10,500 ha, 70 percent of the paddy fields are newly reclaimed paddy fields. Target yield of paddy of eight tons per year will be attained in the whole Project Area in 1990 year, considering the scheduled year for target yield of five years after completion of on-farm development and construction schedule of on-farm development divided into four blocks.

Gross productions in the full development stage are estimated at about 42,000 tons of paddy, while the gross productions without project will be forecasted to be about 6,900 tons of paddy and about 230 tons of upland crops. Based upon these increased production, the incremental NPV in 1990 of the full development stage is estimated at about US$5.0 million (₱37.7 million), which is evaluated on the assumption that the economic farm gate price of paddy is 159 US$/ton (1,160 ₱/ton) in 1977 year and 182 US$/ton (1,375 ₱/ton) in 1985 year.

41. As for the benefit from electric power, the dependable capacity and the average annual energy production are evaluated based on the annual cost of the Bohol Diesel Electric Power Plant which is under construction in Tagbilaran City. The unit power values are estimated at a capacity cost of 85.4 US$/KW (640 ₱/KW) and energy cost of 0.0258 US$/KWH (0.1935 ₱/KWH). By using these unit values of power and energy, an annual power benefit are estimated at US$233 thousand (₱1.7 million).

42. The economic cost to be used for the study on project economic justification consists of construction cost of relevant facilities, O & M cost for irrigation and power and replacement cost for electric power plant. The economic cost is revised from the financial cost under the economic consideration of the items of interest, tax, depreciation cost, unskilled labor cost, oil cost and land acquisition cost. In this procedure, cost allocation between irrigation and power for the joint facilities having duplicating functions such as Pamacsalan dam and Malinao diversion dam is necessary, which is computed by using the Separable Cost Remaining Benefit Method. The Project economic life and escalation factor is decided at 50 years and 8 percent respectively. According to these procedures mentioned above, the economic cost is estimated at US$24.6 million (₱184.8 million) from the financial project cost of US$30.1 million (₱225.7 million) exclusive of escalation factor.

43. The Internal Rate of Return (IRR) for overall project including hydropower is computed at 17.0 percent, in which benefit and cost stream during the 50 years of project economic life are discounted to the present worth with the rate of 5, 10, 15 and 20 percent, respectively. As a result, this integrated agricultural development project would be considered to be justifiable in the economical viewpoint. According to the alternative studies, on the other hand, the IRR of isolated hydropower project is evaluated at only 5.7 percent with low priority, while that of isolated irrigation project rise up to 18.2 percent. To examine the impact of the various assumptions considered in the economic analysis on the rate of return, six cases of sensitivity analysis are made, namely, a) falling of paddy prices, b) increase of construction cost, c) slower built-up on the target yield, d) delays in construction, e) costing farm labor and f) costing construction equipment.

44. The extent of cost recovery would be studied by measuring of cost recovery index. This index is measured at the ratio of incremental water charges paid by all project beneficiaries to incremental project construction and operation and maintenance costs. Water charge on the

Bohol project would be estimated at the equivalent of 3 cavans of paddy per ha in the wet season and 4.5 cavans in the dry season. The tax to be levied from beneficiaries in future would contribute to cost recovery in a view point of the Government fiscal and irrigation sector policies.

Financial analysis was made on the capability of burden of farmers for water charge. The remaining values of net production value deducted the water charge, annual payment for land received by Land Reform, and land rent, etc. would be enough to pay a living cost in future.

45. The following indirect benefits would be expected from the Project in future: a) contribution to self-sufficiency of staple food, b) increase of employment, c) re-dress of income inequality, d) ease energy constraint, e) improvement of transportation networks, f) effect of supporting services and income increase during construction, etc.

B. CONCLUSION

1. The developmental problems of Bohol revolves around low production in rice, fishing, livestock, which was aggravated by poor roads, inadequate irrigation facilities, inadequate port facilities and inadequate power. To cope with these present status, the Government is proposing the strategy for development in long terms, especially putting emphasis on rural development so as to remove the income gap between the rural and urban levels.

2. Bohol Integrated Agricultural Development Project composing of irrigation, agricultural supporting services, road and hydropower components is a link in the events of the Integrated Rural Development Project. Through the careful study on the Project, in which various alternative studies were made to decide the most optimum scale of the project from technical and economical viewpoints. Out of the alternative studies, the Case II-B-2 (multi-reservoir plan) is revealed to

be technically feasible and economically viable as the Project, and then the plan is finally recommended to be the project plan. With the project, the area of about 5,320 ha will enjoy the irrigation benefit which will contribute not only to the acceleration of regional development as well as enhancement of the people's living standard in the area, but also to give a greater effect to the future socio-economic development of Visayan region and the country as a whole.

3. Proposed scope of the Bohol Integrated Agricultural Development Project is, as a conclusion of the feasibility study, delineated as follows:

Irrigation Area

Upper area

Wahig area	:	400 ha
Pamacsalan area	:	120 ha
Lower area	:	4,800 ha
Total	:	5,320 ha

Major Facilities

Pamacsalan dam

Catchment area	:	28 sq.km
Dam type	:	Rockfill dam
Crest level	:	251.5 m
Normal water level	:	248.5 m
Storage capacity	:	30.2 MCM
Dam height	:	67.5 m
Embankment	:	590 x 10^3cu.m
Spillway	:	Gated structure, 600 cu.m/sec

Malinao diversion dam

Dam type	:	Gravity type
Crest level	:	154.5 m
Normal water level	:	152.0 m
Intake water surface	:	145 m
Storage capacity	:	3.4 MCM

Canal and On-farm development

Irrigation canal	:	113 km
Drainage canal	:	98 km
On-farm development	:	5,320 ha

Hydropower

Maximum discharge	:	1.5 cu.m/sec/unit = 3.0 cu.m/sec
Maximum head	:	73.5 m
Generated capacity	:	850 KW x 2units = 1,700 KW
Annual energy production	:	5,175 MWH

Project Cost (Financial)

Foreign currency	:	US$25.2 million
Local currency	:	US$18.4 million
Total	:	US$43.6 million

Project Economics

Internal Rate of Return

Overall project	:	17.0%
Irrigation only	:	18.2%
Hydropower only	:	5.7%

C. RECOMMENDATIONS

1. For carrying out the final design of the Project, following additional topographical survey and geological and embankment material investigations on both field and laboratory will be essentially required in order to obtain sufficient information before proceeding with the design works. A detailed program of recommended surveys and investigation are shown in Appendix 5B-1, and the main items are summarized as follows:

i) Survey and Investigation for Civil Works

Pamacsalan Dam

- Detailed topographic survey around damsite, supplemental survey of reservoir area and a general survey of access and relocation roads.
- Seismic exploration and electric resistivity survey around damsite, and total of 1,230 meters bore hole drillings near the Manaba river mouth.
- Material investigations for the embankment and concrete aggregate.
- In-situ tests for the bedrock and laboratory tests for the embankment and concrete aggregate materials.

Mãlinao Diversion Dam

Irrigation and Drainage Canals

- o Profile and cross-section surveys for the proposed main, lateral and sub-lateral irrigation and drainage canals.

ii) Hydrological Observation

- o Punctual observation of rainfall and water level on the newly installed equipment.
- o Sediment sampling and study for the estimation of sedimentation in the proposed dam.

iii) Agricultural Survey

- o Soil survey and chemical analysis in the Project Area for the preparation of land classification map indicating land capability and soil suitability for crops to be introduced.
- o Cadastral survey in the whole Project Area to make clear the present status of land tenure.

2. The Steering Committee for the Bohol Integrated Agricultural Development Project should be established for the smooth implementation and operation of the Project. Since this Project contains the vast lands to be reclaimed from grass land, effective administrative supports by the Government authorities concerned should be needed for timely completion of on-farm development by land owners, and also, especially for effective and adequate farm management on new paddy field converted from cogon lands.

3. For quick yielding of the agricultural production in the on-farm development project, it is important to provide soonest possible physical infrastructures such as farm roads, on-farm ditches for irrigation and drainage, etc. But it is much more essential to make various legal prearrangements before implementation of the construction works.

4. It is therefore recommended that agricultural development center should be implemented in the Project Area at the earliest possible time. Furthermore, the farmers' organizations for water management and farm operation to increase agricultural productions, for credit and input supply and for processing storage and marketing, etc., which should be carried out timely under the integrated services rendered by the existing agricultural cooperative and extension office.

5. Several alternative studies on the hydropower scheme were made during the feasibility stage. The optimum scheme, however, would be decided based on the long-term construction schedule of NPC and NEA.

6. A side from the construction of project roads along the main and lateral or sub-lateral canals, it is recommended that the provincial roads within the service area including the Pilar-Pamacaslan damsite road will be improved in coordination with the provincial government of Bohol and the Department of Public Highways.

7. According to the water balance study for 20 years from 1956 to 1975 at the proposed diversion site, of which catchment area is 139 sq.km, total actual annual water demand is estimated at about 63.9 MCM on average, while total annual run-off discharge is 110.7 MCM, so that about 46.8 MCM of water per annum is released as invalid discharge at the site. This water could be considered to have a potential to develop the lower area. Under the circumstances, it would be desirable to formulate a master plan at the earliest possible time for the further development of the lower reaches from standpoint of integrated rural development based on sufficient studies in respect of water utilization for irrigation, hydro-power and municipal water supply as well as in respect of the social development.

8. Regarding the development of the Project Area, one alternative plan considering the stage development has been studied in the report. Namely, the first stage (stage I) aims at developing the area of about 2,760 ha by using the available dependable discharge served by the

proposed Malinao diversion dam only, and the second stage (Stage II) might be implemented, when the national economic conditions shall improve to be able to justify the high cost of developing the storage scheme. In the second stage, all of the areas of 5,320 ha will be served by means of the diversion dam and Pamacsalan dam.

The Stage I involve the construction of the Malinao diversion dam, irrigation and drainage systems to serve the area of about 2,760 ha, on-farm development road and supporting services to meet the said areas. The Second Stage comprise of the construction of Pamacsalan dam, irrigation and drainage systems for the remaining areas of 2,560 ha including those of the upper area, remaining on-farm development, road and supporting services as well as hydro-power.

The construction periods of the Stage I is planned to be three years from FY 1981 to FY 1983 and Stage II is planned to start its construction from FY 1984 taking into account long construction periods of the Pamacsalan dam, and will be completed by mid-1987. Under this plan, the four and a half years, from FY 1983 to mid-1987, have been considered to be enough to satisfy the above mentioned conditions.

Following table indicates the result of an evaluation of the plan;

Item	Stage Development (Alternatives)		
	Stage I	Overall Plan	Project Plan
Irrigation area (ha)	2,760	5,320	5,320
Project cost (million US$) 1/	11.1	26.5	26.2
Cost per hectare	4,010	4,410 2/	4,310 2/
Internal Rate of Return (%)	17.2	16.4	17.0

1/: cost estimated by the depreciation basis for construction equipment and no inclusive of construction equipment cost and price escalation.

2/: exclusive of allocated hydro-power cost.

As seen in the table, it is clear that the Project Plan is justified to be more recommendable than the stage development plan, that is, the IRR of the Project Plan is evaluated at 17.0 percent while 16.4 percent for the Overall Plan in stage development, and furthermore the initial cost per hectare of US$4,310 of the Project Plan is lower than US$4,410 per hectare in case of Stage development. However, stage development of the project in the phasing manner might be formulated when the financial cost required at initial stage is accounted into consideration, because the initial cost of Stage I is estimated to be US$11.1 millions, which is equivalent to 42 percent of total cost of Project Plan. But the dam construction would be prerequisite for the project in order to materialize an effective utilization of the limited water resources and maximum efficiency of investment as well as quick benefit under the stabilized water supply by means of dam.

Through these considerations, the recommended Project Plan is deemed to be the best scheme for the project.

9. Project implementation of Integrated Agriculutral Development Project on the Wahig-Pamacsalan area will bring about benefits created through the irrigated agricultural farming to the inhabitants in the Project Area and its vicinity, and furthermore various socio-economic impact as indirect benefits could be expected from viewpoint of national and regional levels. However, the whole Province of Bohol identified with Integrated Rural Development Project is a depressed area with problems and thus needs to be developed. The major development problems are a) low production, b) inadequate of irrigation system, c) poor road, d) inadequate port facilities, e) inadequate power system, f) low per capita income, g) poor health standards and so forth. To cope with these circumstances, the master plan for the development in the province should be formulated at the earliest possible time from the standpoints of the Integrated Rural Development Project. Through the study for the development, the priorities in development will be made clear.

CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

The Government of the Philippines made a request to the Government of Japan for technical cooperation to formulate the Bohol Integrated Agricultural Development Project and then, the Government of Japan dispatched the preliminary mission to make survey of the projects as well as to have deliverate discussion in positive manner in this regard. Finally, the Team headed by Mr. Susumu Takamine was dispatched to conduct the Feasibility Study, the first promising project in compliance with the Bohol Integrated Rural Development. The Proposed project contains four components: irrigation, road, hydropower and agricultural supporting services.

The final Report has been prepared by the Team, together with the Government Staff from NIA in adcordance with the Scope of Work for the Feasibility Study, of which outline is summarized below:

i) to examine and evaluate all data and information available on the Project Area including its vicinities, to carry out necessary supplementary studies and to assess the overall development potential of the proposed area;

ii) to draw up an integrated agriculrural development plan for the Project Area which includes agricultural supporting services;

iii) to suggest an implementation program including the proposed mades of implementation, organization, institutional arrangements, phasing and a time schedule;

iv) to examine the need of consulting services for implementation of the Project and propose the framework of such services with expertise, assignment schedule, outline of terms of reference, etc. The proposal should include approximate costs of consulting services required;

v) to work out the project investment cost required, inclusive of a breakdown into foreign and local currency components, taking into account the alternative modes and schedule for project works and other related activities.

vi) to complete the economic analysis of the development project in accordance with standard procedures internationally accepted and to submit the final feasibility report including a definite project proposal in an appropriate form for immediate appraisal and implementation;

vii) to make recommendations, in its final report, on preparatory work for implementation of the project and other necessary measures to be taken by authorities concerned for smooth implementation of the project and other necessary measures to be taken by authorities concerned for smooth implementation and quick accrual of the project benefits;

viii) to assess the need of a pilot farm scheme in the project area and to locate possible site for it;

In compliance therewith the Team completed the field survey and detailed study in the feasibility level for the Integrated Agricultural Development in about 7,300 ha at the eastern central part, about 60 km northeast from Tagbilaran in the Province of Bohol.

The report covers the results of field studies carried out by the Team together with the Government Staff from August 22 to November 26, 1977, and also, incorporates all the provisions in respect of interim discussions held between the Government of the Philippines and the Team on October 6 and November 7, 1977.

Tabulated hereinafter are the Advisory Group, Team members and Counterpart personnel of NIA assigned to the Project.

Advisory Group Assigned to the Project

1.	Chief Adviser Mr. Tadashi YOSHIMITSU	Senior Irrigation Specialist Design Division, Agricultural Structural Improvement Bureau, Ministry of Agricultural and Forestry.
2.	Adviser Mr. Masakuni KAWAMATA	Assistant Director (Irrigation) General Affairs Division, Agricultural Structural Improvement Bureau, Ministry of Agricultural and Forestry.
3.	Adviser Mr. Takashi KAWAZOE	Assistant Manager 2nd Division, Loan Department II The Overseas Economic Cooperation Fund.

Team Members Assigned to the Project

1.	Team Leader Mr. Susumu TAKAMINE	22 Aug. - 26 Nov., 1977
2.	Irrigation Mr. Seiji TAKEUCHI	22 Aug. - 26 Nov., 1977
3.	Drainage and On-farm Mr. Masahiro IIDA	30 Aug. - 17 Nov., 1977
4.	Meteorology and Hydrology Mr. Toshimasa KOBAYASHI	30 Aug. - 17 Nov., 1977
5.	Soil Mr. Norio KOIWA	30 Aug. - 13 Oct., 1977
6.	Geology Mr. Mitsuru YOSHIKAWA	30 Aug. - 25 Sept., 1977 6 Nov. - 26 Nov., 1977
7.	Dam Planning Mr. Tetsuro HORI	30 Aug. - 17 Nov., 1977
8.	Dam Design Mr. Koichi INOUE	30 Aug. - 17 Nov., 1977
9.	Canal Design Mr. Yasuo TERAMURA	18 Sept. - 26 Nov., 1977

10.	Electric Power Mr. Yoshiaki SHIMIZU	17 Oct. - 16 Nov., 1977
11.	Agronomy Mr. Yasunori HASEGAWA	30 Aug. - 17 Nov., 1977
12.	Institution and Rural Development Mr. Tatsuo HAMAJIMA	18 Sep. - 31 Oct., 1977
13.	Agro-economy Mr. Shoji YAMADA	18 Sep. - 26 Nov., 1977

Counterpart Personnel Assigned to the Project

1.	Mr. Jose B. del Rosario, Jr.	Project Development Director (Overall Coordinator)
2.	Mr. Serafin A. Palteng	Chief, Planning Division
3.	Mr. Bonifacio A. Alburo	Chief, Land Resources & Economic Division
4.	Mr. Isidro R. Digal	Chief, Feasibility Study Section
5.	Mr. Wilfredo D. Silva	Irrigation and Drainage Engineer
6.	Mr. Clemente T. Alanano	Chief, Dams and Reservoir Section
7.	Mr. Epifanio C. Gacusan	Chief, Economic Section
8.	Mr. Dominador D. Pascua	Chief, Land Use Section
9.	Mr. Orlando F. Gascon	Power Engineer
10.	Mr. Orlando C. Villalon	Geologist
11.	Mr. Rolando M. Maloles	Hydrologist
12.	Mr. Conrado Q. Tingson	Soil Technologist
13.	Mr. Leonardo T. Costa	Agronomist
14.	Mr. Primo B. Villanueva	Agro-economist
15.	Mr. Francisco A. Alhambra	Sr. Planning Engineer
16.	Mr. Renato M. Resuma	Sr. Planning Engineer
17.	Mr. William L. Reodica	Sr. Planning Engineer

18.	Mr. Asterio M. Dagang	Planning Engineer
19.	Mr. Jovito A. Navarro	Supervising Hydrologist
20.	Mrs. Leticia O. Cruz	Sr. Investigation Engineer
21.	Mrs. Helen G. Ramirez	Planning Engineer
22.	Mr. Rogelio N. Barwelo	Planning Engineer
23.	Mr. Edgardo P. Jacinto	Planning Engineer
24.	Mr. Calixto M. Seroje	Provincial Irrigation Engineer, Bohol

CHAPTER II. ECONOMIC AND SECTORAL BACKGROUND

CHAPTER II. ECONOMIC AND SECTORIAL BACKGROUND

A. National Level

The Philippines covers about 300,000 sq.km scattered over more than 7,000 islands. The population is about 42.5 million as of 1975, and the density of population is about 139 persons per sq.km. There are 12 regions and about 70 provinces in the entire country. The Region IV, Metro Manila area, with an area of 636 sq.km has around 5 million population and the density of population is about 7,600 persons/sq.km as of 1975. The next regions with highest density are Region III (Central Luzon) with 229 persons and Region VII (Central Visayas) with 225 persons, in which Cebu Province having population density of 355 persons is included. (See Table 2A-1 to 2A-2, in Appendix 2A-1)

Real GNP (1967 constant prices), which had a growth rate of about 6 percent in 1966-1970, had achieved by 10 percent in 1973, but has grown only at about 6 percent in 1974-1975 due to recession. On the sectorial GDP, construction sector shows the highest growth rate at 52 percent and 22 percent in 1974-1975 and 1975-76 respectively in 1972 constant prices. Manufacture sector, which had achieved 14 percent in 1972-1973 recovered from 3.5 percent (1974-1975) to 5.6 percent (1975-1976) after oil crisis in 1974. (See Table 2A-3, 2A-4 in Appendix 2A-2)

Agricultural sector, which occupy about 26 percent of GDP, grew to 5.8 percent in 1975-1976 because of good production of cereal in spite of the partial rice damage from typhoon and flood. As a result, rice was not imported in 1976. (See Table 2A-4, Appendix 2A-2)

The rates of consumer commodity prices in Manila were 11 percent in 1973, 34 percent in 1974 and 8 percent in 1975 respectively. Taking into account the economic progress as mentioned above, it may be said that the Philippines national economy in the recent two or three years are progressing under stability.

The Government of the Philippines has formulated as the national aspirations for the Year 2000, the Long-term and Five-Year (1978-1982) Development Plans (Draft Summary) in 1977. As major goals, political stability, self-reliance in basic needs, high level of industrialization, rural and regional development, resource adequacy and development are aspired. To achieve these goals, the government should have to cope with a number of pressing problems and challenges in the future in spite of the modest economic progress as mentioned above.

The critical problems to be challenged in the coming decade are inadequate supply of basic needs, income inequality, unemployment and underemployment, heavy pressure of a rapid population growth, balance of payments and price unstability, and energy constraint.

The strategy for national development mentioned above is based on the achievement of GNP to grow at average annual rate of approximately 8 percent by the year 2000 (at constant 1972 prices). This strategy is intended to provide more productive employment to a growing labor force, and food and basic services to a rapidly urbanizing society, and thus decrease the income gap between the social groups and within the regions.

According to Long-term Development Plans, by the year 2000, agriculture sector will be highly modernized and diversified, contributing about 17 percent of the total nation output. By 1987, rice, corn and coconut will continue to be the major crops in terms of land area. Self-sufficiency will be attained and maintained in basic food commodities in the next five years. And by the year 2000, a total area of 2.8 million ha or 82 percent of potentially irrigable land under irrigation will be attained. Consequently, by 1987, the projected demand for irrigated rice lands will be in equilibrium with the supply. (See Figure 2A-1 in Appendix 2A-2)

B. Regional/Provincial Level

Region VII (Central Visayas) consists of four island-provinces of

Bohol, Cebu, Negros Oriental and Siquijor and the populations for these 4 provinces were 750, 1,800, 740, and 70 thousands persons, respectively in 1974. These populations had a trend of annual increase rate of 2.1, 2.0, 2.5 and 1.6 percent respectively from 1970 to 1975. Population and employment of Central Visayas occupy only about 8 percent of the entire Philippines in 1975. The gross regional domestic product per capita in 1975 shows 1,257 pesos at 1972 prices in comparison with 1,601 pesos of national average value. This value in the sixth of the nationwide twelve regions and is forecasted to achieve the fourth by the year 2000 according to Long-term Development Plan. (See Table 2B-1, 2B-2, in Appendix 2B-1)

Bohol island is reached from Manila by one hour jet flight to Mactan Airport in Cebu with a 30 minute connecting flight to Tagbilaran. By sea, it could be reached by taking inter-island ships by Manila-Cebu-Tagbilaran routes.

Bohol province is among those categorized as depressed areas. In 1971, it had a per capita income of only 425 pesos which was below the national average (566 pesos). Then in spite of the increase of the total population, the total gainful workers in province are decreasing. However, workers in the first industry has increased in contrast to a decrease in the second and third industry in recent years. This means that the provincial agricultural sector has a high capacity of absorption for unemployment.

To effect a well-balanced regional growth, agricultural development must be pursued to realize a maximum production by using the potential resources. Cabinet Coordinate Committee[1/] on Integrated Rural Development Projects, reported "Integrated Development Package for Bohol." Major problem as development programs is summarized in low agricultural production characterized by low yields. Physical

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1/ CCC adopted the following strategy for development: entire package of projects, tapping major resources of the Province in areas with high resource potentials, projects in support of export and high income generating industries.

factors causing low production are inadequate irrigation, poor roads, inadequate port facilities and inadequate power. This low production gives such social impact as low per capita income, poor health standards and inequalities in income distribution, etc.

Through this strategy, the area of North-East Basin was taken up as an integrated project with the highest-priority to be given. Following this strategy, NIA and NEDA conducted an area resources study of the Wahig-Pamacsalan Project. The result of the study was published in 1976.

NIA has the ten years plan of irrigation (1974-1975 to 1984-1985). In Bohol province, three national projects of Wahig-Pamacsalan, Bulilis and Cayacay with 12,000 ha and communal and pump projects with 13,000 ha are planned. About 4,500 ha, 20 districts of the latter are already studied under IBRD loan projects which will not overlap with the Wahig-Pamacsalan Project area. And the development project on port, electric plant and health facilities are under IBRD study.

CHAPTER III. THE PROJECT AREA

CHAPTER III. THE PROJECT AREA

A. Location and General Features

1. Geographical Location and Road Systems

The Project Area covering an acreage of about 7,300 ha is located on the eastern central part of the Province of Bohol, and extends to the Municipalities of Pilar, Dagohoy, Sierra Bullones, San Miguel and Alicia, about 60 km northeast of Tagbilaran City, the capital and commercial center of the Province.

The Project Area is bounded on the north and northeast by a series of hills, on the west-southwest by the Wahig river, the national highway No.3, a feeder road linking the Poblacion and the Barrio San Jose and Bugsoc of Sierra Bullones and on the south-southeast by a chain of hills which is partly traversed by the national highway and the Pamacsalan river.

Three types of roads exist in the Project Area and its vicinity; a national highway of asphalt, cement or gravel pavement provides all weather access to the Municipalities mentioned above from Tagbilaran City. Two unpaved provincial roads branching off from the national highway traverse the greater part of the Project Area and the Barrio roads branching off from the above-mentioned two types of road are provided for the transportation of the barrio level. However, all of the roads except the national highway are dry-weather road, consequently, the transportation of living materials, agricultural inputs and outputs as well as the communication between barrios is difficult in the wet season due to poor road networks conditions.

2. Population and Living Conditions

Number of Municipality and Barrio concerned to the Project are 5 and 24 respectively. The population in 1975 was about 759,000 in the Province, 64,000 in the five Municipalities and 21,300 in the

Project Area. The annual population growth rate of 2.9 percent in the Project Area should be noted in comparison with 2.1 percent in the Province. The employment ratio of experienced workers, 10 years old or over, engaged in the first industry is about 70 percent in five Municipalities as of 1970. Craftsman, production process workers and laborers occupy 14 percent. Inspite of a decrease of gainful workers engaging in the second and third industry, workers in the first industry has increased in recent years. (See Table 3A-1 to 3A-4 in Appendix 3A-1)

Number of farmers is 6.0 persons per household, of which under 9 years old is 2.0 persons, 10 to 19 years old 1.5 and over 20 years old is 2.5. (See Appendix 3A-2 and 3A-5 in Appendix 3A-1)

Electric transmission line is not yet provided. A few rich people have own electric facilities with storage battery, however almost all people use kerosene lamps for lighting. According to the socio-economic survey conducted by Office of the Secretary, Department of Agriculture, June 1976, the living conditions are as follows. This survey was conducted in 14 municipalities of which San Miguel and Dagohoy concerned to the Project and Ubay, Carmen, Danao and Candijay adjacent to the Project are included.

Level of Living Indicators of Farmers

Item	Number Reporting	Percent to inquired farm household
Transistor radio	132	70
Portable record player	8	4
LPG stove	6	3
Wood stove	109	58
Electric lights	5	3
Kerosene lights	173	92
Dining table and chair	163	87
Sewing machine	47	25
Kitchen cabinet	81	43
Bed	106	56
Other1/	15	8

Note: Inquired farm household: 188
1/ Cabinet, refrigerator, T.V. set, motorcycle and typewriter.
Source: Socio-Economic Study of Farmers in Bohol. Office of the Secretary, Department of Agriculture, June, 1976

Items most frequently reported were kerosene lamps, dining table and chair and transistor radio. On the other hand, items least frequently reported were electric lights and LPG stove.

Pilar Municipality has a simple drinking water supply system established by the government in 1941. Number of users are 80 households who live in the Barrio of Pablacion, Lumboy and Del Pilar. Other peoples without water supply facility use water from open wells, small springs and artesian well. One Barrio has one artesian well, open wells of 10 and small spring of 5 on average. Then, it is considered that the inhabitants having no water system in areas is not pressed at present.

Socio-Economic study mentioned above has the following interesting question among many items. Since the survey was conducted within urban Municipalities of Talibon, Tubigon, Mabinic and Candijay, the findings through survey does not deem to meet those in the Project Area, but it could be considered that they express the general status of living conditions in the area.

Do You Have Running Water in Your House

Answer	Number Reporting	Percent of inquired farm household
Yes	77	41
No	111	59
If no, where do you get household water?		
Own well	47	42
Communal well	46	41
Rain water	13	12
Spring	5	5

Note: Inquired farm households: 188

B. Physical Conditions

1. Topography

The topography of the Project Area shows the different features between the upper and lower areas, which could be divided into two areas from viewpoint of topography. The former area is developed along the Wahig and Pamacsalan rivers at the upstream of confluence of the said two rivers, and the latter area is spread with some undulation between the Wahig river and series of hill located on the north and northeast.

The upper area, particularly the proposed irrigable lands, is described as a generally vast expansion of rolling terrain intercepted with flat and gently sloping valley, except for pockets in level portions along the Wahig and Pamacsalan rivers. These gently sloping and flat valleys with the elevation ranging from 240 m to 145 m above mean sea level are located in the Barrios of Bugsoc, San Jose, Canlangit, Pamacsalan, Aurora and Dagohoy and the Poblacion of Serra Bullones.

On the other hand, the lower area is formed by a range of moderately rolling plain with intervening hills, with elevations rainging from of 145 m to 100 m above mean sea level. Such areas are common throughout the service area, particularly in the Barrios of Kagawasan, Estaca, San Isidro, Buena Suerte, Katipunan, San Miguel, Babag, Dagohoy and Caluasan. The lowland areas between the rolling hills generally play a role of natural drainage canals and are at present utilized for the rainfed paddy fields.

2. Climate and Hydrology

(a) General

The type of climate in the Philippines is normally categorized into four types in accordance with the rainfall distribution pattern in the year. The Bohol island belongs to the climatic type IV of which rainfall is more or less evenly distributed throughout the year.

Comparing the annual rainfall, however, between Tagbilaran and Dagohoy stations, the rainfall at Tagbilaran is 1,486 mm/year while the one at Dagohoy is 2,134 mm/year. The rainfall at Dagohoy is 44 percent higher than the one at Tagbilaran. The characteristics of the rainfall pattern in the Project Area would be somewhat different from the climatic type IV.

In the Project Area, there are two existing raingauge stations at Dagohoy, operated by PAGASA, and Pamacsalan, operated by BPW, and two water level gauging stations in the Wahig river at Bugsoc and in the Pamacsalan river at Pilar. Meteorological data have been observed at Tagbilaran synoptic station only in the Bohol island. Generally, the features of meteorology in the Bohol island, such as temperature, relative humidity and wind velocity shows quite moderate fluctuation throughout the year. Mean monthly temperature varies from 25.9°C to 28.4°C, relative humidity from 79% to 84% and wind velocity from 4 km/hour to 6 km/hour, respectively. As for the prevailing wind direction, the Bohol island is affected by the north-west monsoon from October to May and by the south-west monsoon from June to September. Twenty three typhoons were recorded in the Tagbilaran station during 28 years from 1948 to 1975, out of which 9 typhoons, that is about 40 percent of total typhoons, were concentrated in November only.

New hydrological gauging stations have been established in the Project Area during the period of field investigation. Two self-recording raingauges (3-month record) have been conceded by the Government of Japan and they have been installed at Matinao and Abakanan. A self-recording water level gauge has been found at the gauge keeper's house of the Wahig river which was originally installed at the Wahig river at Bugsoc but the gauge had been flushed out by a flood in 1967. Since the Pamacsalan dam would be a main supply of water resource for the project, re-installation of the gauge at the Pamacsalan river has been agreed by the BPW. The detailed explanation on each station can be referred in Appendix 3B-1, page 3. The following new gauging stations have been installed in the Project Area.

Raingauge Station:

1. Matinao : Automatic and standard raingauges
2. Abakanan : Automatic and standard raingauges and evaporation pan
3. Danicop : Standard raingauge and evaporation pan
4. Catagdaan : Standard raingauge

Water Level Gauging Station:

1. Automatic water level gauge in the Pamacsalan river at Pilar
2. Staff gauges in the Wahig at Bugsoc and Siera Bullones, in the Binabae river at Bugsoc, in the Bagunan river at Pilar and the confluence of the Wahig and Pamacsalan river at the proposed Malinao diversion dam site.

(b) Available Hydrological Data

Five raingauge stations at Tagbilaran, Ubay, Tubigon, Dagohoy and Pamacsalan have continued the observation in the Bohol island, out of which at Dagohoy and Pamacsalan stations are located in the Project Area. The daily rainfall data at Dagohoy from 1956 to 1976 and the one at Pamacsalan from 1967 to 1976 have been collected.

On the other hand, the monthly rainfall at Tagbilaran from 1920 to 1940 and 1960 to 1975 have been collected in order to find the stochastic trend of rainfall.

Hourly rainfall has been observed at Tagbilaran and Dagohoy in the Bohol island, however the observation period in the both stations is limited within two years only from 1975 to 1976. No remarkable high rainfall has been recorded in both stations. As the daily maximum rainfall at Cebu and Dagohoy are rather similar, the hourly rainfall data at Cebu has been collected though the hourly rainfall was intermittently observed. The maximum observed daily rainfall at Dagohoy is extremely high that is 513.3 mm/day. The similar daily rainfall was observed at Surigao Del Norte, so the hourly rainfall data has also been collected. The collected hourly rainfall patterns are shown in the Appendix 3B-2.

The daily discharge data at the Wahig and Pamacsalan rivers have been collected from 1956 to 1976. The discharge at the both stations are affected by communal intake located at the upstream of the stations. The gauging station at the Wahig river, however, replaced to the confluence of the Wahig river and Binabae river but the date of replacement was unknown. Also the rating curve was prepared in 1959.

The flood hydrographs in the water level only have been observed at the Wahig river from 1964 to 1967. However, the data of hourly rainfall on the simultaneous date was not observed.

The discharge measurements have been conducted for 20 times during the field survey at the Pamacsalan, Wahig, Binabae, Bagunan and confluence of Wahig and Pamacsalan rivers. The results of the measurements are shown in Appendix 3B-2, page 13.

(c) Hydrological Analysis

(1) Rainfall Analysis

According to the collected rainfall data, the monthly average for 21 years from 1956 to 1976 shows that the rainfall is more or less evenly distributed throughout the year, which is the general characteristic of the climate type IV. As seen from the monthly rainfall in each year, however, the rainfall indicates quite distinct dry month almost every year. Especially in 1969 and 1973, it is clear that there is a five month dry season from January to May and the total rainfall in the five months in 1973 is only 103.4 mm/5-month at Dagohoy station and 89.4 mm/5-month at Pamacsalan station. These specific years in the dry season are quite similar condition in the climate type I prevailing in the north-west Luzon island. Therefore, it can be said that there is not so much distinct dry season, but there is a distinct dry season in almost every year but the starting month as well as the duration of the dry season fluctuate year by year.

During wet season in August or September, the monthly rainfall

falls in less than 100 mm/month, that has been occurred five times in the 20-year period. In the average, monthly rainfall in August is almost the same as in February and also the evaporation amount becomes almost the same as the monthly rainfall in August. It can be said that some of year in August or September the rainfall falls in a dry month. Such specific characteristics will fix the scale of water resource development.

The linear correlations of the monthly rainfall at Dagohoy, Pamacsalan, Tagbilaran and Cebu stations have been analyzed. The coefficient of the correlation between the Dagohoy and Pamacsalan is 80.7 percent which are quite good but those for the other stations are less than 60 percent which is quite poor. As the Pamacsalan rainfall data includes some missing data and the observation which started from 1967, the Pamacsalan daily rainfall has been complemented from the Dagohoy rainfall data directly for the missing data for the years from 1956 to 1966.

In order to find the stochastic trend of annual rainfall in the long term trend and to evaluate the possition of the drought condition in the recent 20-year period, which will be used for the subsequent reservoir water operation study, the annual rainfall at Tagbilaran from 1902 to 1940 and 1961 to 1975 and the one at Manila from 1865 to 1964 have been analyzed by taking the overlapped moving average of 3-year, 5-year and 10-year. These results have been compared with the moving average of Dagohoy annual rainfall. The comparison of the results are shown in Appendix 3B-3, page 4.

General trend of annual rainfall at Tagbilaran shows rather similar pattern to that of Manila, though the magnitude of the rainfall is different from each other. The average of annual rainfall at Tagbilaran from 1917 to 1939 is 1,742.4 mm/year, while the one from 1960 to 1975 is 1,485.5 mm/year so that the rainfall in the recent year becomes about 15 percent less than the former year. The droughtest period during 70 years since 1900 appeared around 1965, especially, the 3-year

moving average shows that the droughtest condition appears in 1965. According to the 10-year moving average of annual rainfall at Manila station, the droughtest condition appears in 1885 and the year from 1865 to 1900 is droughter than the recent 30 years from 1940 to 1970 and the year from 1900 to 1940 for 40 years belongs to the wet year. The recent 20-year from 1956 to 1976 belongs to rather drought year. Accordingly, the recent 20-year period will be suitable to analyze and decide the scale of development and required reservoir capacity for the Project.

In order to estimate the design rainfall for the drainage canal in the irrigation area, the daily maximum rainfall and successive 2-day to 4-day maximum rainfall have been analyzed in the Dagohoy station to estimate the rainfall amount in each return period. The maximum observed daily maximum rainfall is 513.3 mm/day on 19th November 1964 which is extremely high rainfall compared with the second maximum of 159.5 mm/day in 1968. Therefore, the observed maximum rainfall has not been considered for the probability analysis for the design rainfall analysis of drainage capacity. As for the successive rainfall analysis, the incremental ratio from 2-day to 3-day and 3-day to 4-day become rather small. It will be no necessary to consider the successive rainfall more than 3-day. The daily maximum rainfall for the 5-year and 10-year return periods are 120.0 mm/day and 135.0 mm/day respectively, and the 2-day successive maximum rainfall for the 5-year and 10-year return periods are 168.0 mm/2-day and 185.0 mm/2-day, respectively.

(2) Long Term Streamflow Analysis

It was found that the daily rainfall pattern at Dagohoy and Pamacsalan is a little bit different from each other. Compared with the Pamacsalan observed discharge data, the Pamacsalan rainfall data has been used for the streamflow analysis.

Since the Pamacsalan observed data is affected by the communal intake located about 200 meters upstream from the gauging station, also, annual total of discharge height becomes more than the annual rainfall in 1974 and 1975, that is, the runoff coefficient becomes more than 100 percent, it is necessary to verify the observed data and to estimate the natural condition of river streamflow to use the subsequent reservoir water operation studies. The Tank Model Method has been adopted to estimate the natural condition of river flow. The parameters of the each tank have been decided by way of comparing the observed and computed value. Therefore the trial-and-error method have been used so many times on the daily basis to find the sufficient agreement between the computed value and observed one.

The final results of the computed discharge height together with the observed data are shown in Appendix 3B-3, page 11. The coefficient of correlation between the observed and computed value is obtained 83 percent on monthly basis from the period of 1967 to 1973. Accordingly, the computed values have been used for the reservoir water operation studies as the natural condition of the Pamacsalan river.

There is no data observed at the Malinao diversion dam site and Bagunan river. Considering the results of the discharge measurements, it will be rather dangerous to use the ratio of the catchment area to estimate the river flow at each structure site. The ratio of catchment area, ratio of simultaneous discharge measurements, and the correlation between the specific annual average discharge and weighted average of river slope have been compared.

Comparing the results of the ratios against the Pamacsalan discharge data, the estimation of the discharge at the Wahig proposed dam site has been adopted the ratio of the catchment area. The discharge at the Malinao diversion dam site and Bagunan dam site have been estimated by the ratios of the simultaneous discharge measurements because the adopted ratios are the smallest among the three ratios.

(3) Evapotranspiration Analysis

In the Philippines, a research had been performed to find the correlation between the pan evaporation data and the crop water requirement of paddy field and the obtained result shows more than 80 percent of the coefficient of correlation. Normally, the crop water requirement for paddy field has been estimated directly from the pan evaporation data.

There is no evaporation data in the Bohol island. The Penman's formula has been adopted to estimate the evaporation values from the climatological data at Tagbilaran. The estimated evaporation values are normally rather small compared with the pan evaporation data. Monthly revision factors have been estimated by the observed pan evaporation data and the computed evaporation values from the climatological data at the Lullimas University, Dumaguete City in Negros Oriental. The results of the analysis are shown in Appendix 3B-3, page 24.

According to the obtained monthly revision factors, the computed evaporation values by Penman's formula for the Project Area has been adjusted. The adjusted evaporation values on monthly basis have been used for the crop water requirement in the paddy field. The average annual adjusted evaporation value amounts to 1,985 mm/year.

(4) Flood Analysis

The maximum observed daily rainfall at Dagohoy station is 513.3 mm/day on 19th November, 1964. The daily rainfall data in the Visaya region in November 1964 for 16 stations have been collected to find the similar rainfall on the simultaneous date of the said rainfall amount. 202.4 mm/day rainfall has been observed at Nipa Palanas in Masbate on the same date as the second maximum. Actually, no such high rainfall amount has been observed in the Visaya region. However, at the Sungao Del Norte, which belongs to the climate type II, 582.1 mm/24-hour rainfall has been observed on 18th November, 1968.

On the other hand, a flood mark in a old church near the Loboc river, which is adjacent to the Wahig river, has been found and dated in November 1867.

Considering these historic records, it might be better to use a extreme flood peak for the design of spillway for the proposed dams. Two equations to estimate the peak discharge to be adopted for the design discharge for the spillway, have been used. The one is estimated by M.M. Obradovich on the basis of the observed peak discharge in the several regions in the Philippines and considering the climate type IV, the equation in the Mindanao has been adopted. The other one is proposed by the BPW for different frequencies namely extreme, rare, occasional and frequent.

Comparing the results of the both equations, the peak discharge for the Pamacsalan dam and Wahig dam has been estimated by the BPW equation which gives higher value than the other. As for the Malinao diversion dam, it might be controlled the flood peak by the Pamacsalan reservoir and also it has been found that the discharge from the Bagunan river is rather small compared with its catchment area. Therefore, the peak discharge for the Malinao diversion dam has been estimated by the equation of M.M. Obradovich.

Consequently, the disign peak discharge for the Pamacsalan Dam has been decided at 930 cu.m/sec and the one for the Malinao Diversion dam is 1,600 cu.m/sec.

(d) Water Quality Analysis

Two times of water sampling at the site have been made on 12th July 1975 and 19th September 1977. The water quality analysis have been conducted at the Laboratory Services Division of the Bureau of Soil for the former samples and at the Bureau of Public Works for the later smaples. The results of the water quality analysis are shown in the Appendix 3B-4. According to the results of the analyses, no peculiar chemical contents have been found in the river water and it can be conlcuded that the water is quite suitable for irrigation purpose.

(e) Sediment Volume in the Reservoir

The samplings of the suspended load have been performed several times during the course of the field investigation. However, the river water was so clear that the suspended load as well as wash load could not be observed in the samples.

Four samples were taken on 12th July 1975 by the staff of the Philippines Government at the Pamacsalan river and the Wahig river in two samples each in the former study stage. It is almost impossible to use the only one datum for the sediment analysis. Accordingly, four different methods namely, i) Design criteria for fill type dam's method, ii) Kira's method, iii) Multiple regression analysis method, and iv) L.C. Gottschalk's method, have been selected to analyze the sediment volume in the reservoir from the general data, such as catchment area, size of reservoir and river slope. The specific sediment volume per year becomes the highest by the L.C. Gottschalk's method at 602.8 cu.m/se.km and becomes the lowest by the multiple regression analysis method at 184.9 cu.m/sq.km as shown in Appendix 3B-4.

Considering the values obtained, geological conditions in the reservoir area, the vegetation in the catchment area which is rather good conditions and the rainfall intensify, 400 cu.m/sq.km/year has been decided to be adopted for the sedimentation volume in the reservoir. The 100-year sediment volume has been adopted on the basis of the life time of the dam. The sediment volumes, therefore, for the Pamacsalan and Wahig reservoirs have been decided at 1,120,000 cu.m and 920,000 cu.m, respectively.

3. General Geology and Soil

(a) General Geology

Pamacsalan Dam

The proposed Pamacsalan dam and reservoir site are situated in the north-east wing of the anticline structure. The rock facies of the sites are mainly composed of marly limestone of the Upper Miocene to Pliocene and on the lower reach of the limestone formation alternations of shale and sandstone are seen. Almost of the reservoir area consists of the alternation of shale and sandstone, on the other hand, the dam foundation and both abutment consist of the marly limestone formation.

The limestone formation is apparently sound, massive and less fructured, however, it may be pervious. On the other hand, the alternation of shale and sandstone consists mainly of shale, and it is being generally impervious and soft.

Karstism marks such as cave, sinkhole and depression were found in the limestone formation around the damsite.

On the left abutment, so-called Pamacsalan cave is formed with two parallel horizontal caves which are connected by the roof falling on an elevation around 350 m of comparative narrow rim and also on the very neighborhood of downstream of the dam axis, a large scale depression is spread out, in which a narrow waterfall drains water out in the basin and numbers of sinkholes in sizes can be seen inside the basin.

The mountain slopes are covered with residual overburden of rather thickly, originating from decomposition of either limestone or alternation of shale and sandstone.

Landslide in small scale spread out in the reservoir area.

Malinao Diversion Dam

The Malinao diversion dam is proposed at the immediate downstream site of the confluence of Wahig and Pamacsalan Rivers for diversion and storage purposes.

The topography around the site is hilly with a gentle slope. The both banks of the site continue on ridges of around 160 m summit level..

The geology around the site is composed of an alternation of sandstone and shale, predominant with hard massive sandstone layers. And the bed rock formation is exposed on the river bed.

The ridges on the both banks show moderate undulation, and partially earth dykes several meter high might be necessary. No investigation onto foundation of dam and dykes have been made yet. However, the thickness of overburdens are deemed to be not so big. Since the bed rock consists mainly of an impervious sandstone layer, no seepage problem may be predicted.

(b) Soil

Out of the 7,300 ha surveyed area, about 4,000 ha of lands have a gradient less than three percent, about 2,200 ha of lands are situated on three to five percent sloping land and remaining lands have five to seven percent slope. Therefore, grade of sloping is considered as the key factor for the mapping unit of land classification.

The soils of the project area are mainly originated from sedimentary rocks (shale, sandstone, siltstone, mudstone and marl) but soils of the southern parts of Upper area have been developed under influences of limestone. Two prevailing soil series, Canlangit and Ubay soil series, are found in the Project Area. Canlangit soil is found in the southern parts of Upper area and it totals about 330 ha, while Ubay soil is found in the northern parts of Upper area and in the Lower area, and it occupies about 6,970 ha of land.

Canlangit series is a member of the fine clayey moderately deep and somewhat poorly drained soils. This soil is distributed on nearly flat river terraces sloping on undulating portions. They are mainly used for paddy field under the communal irrigation system except for limited portions planted with coconut and other crops. This soil is strongly affected by weathered limestone materials and very fine white limestone particles are found throughout the horizons. Consequently, the cation exchange capacity (CEC) is very high and base saturation percentage is also high. These facts will indicate that these soils are hardly leached out and rich in exchangeable bases. The soil reaction ranges from 7.1 to 8.0.

Ubay series is a member of the fine clayey family, moderately deep, slightly well drained soils. This soil is located on almost flat and depression area, and locally surface gradients vary between two to seven percent. Ubay soil has quite different characteristics compared with Canlangit soil. That is the presence of lateritic gravelly concretions at a depth of less than 80 cm, mostly between 20 to 60 cm with varying thickness from 20 to 40 cm. Usually, these concretions are embeded in clay loam or clay which is brown to yellowish brown and generally shows a strong multicolored mottling. The indurated ironstone layer was found at the depth of 30 to 85 cm during the field investigation. This occurrence will indicate the presence of extensive ironstone layer in elsewhere within the Lower area. Ubay soil has moderately strong acid reaction and low CEC and base saturation percentage compared with Canlangit soil. These phenomena seems to exist mainly due to the bases leaching by rainfall.

Both Canlangit and Ubay series appear slightly poor in natural nutrients and also having soil deficiencies such as clayey texture and presence of ironstone concretion gravelly layer.

The extent of each soil mapping units in the Project Area are summarized as follows;

Soil Mapping Unit in the Project Area

Soil Mapping Unit	Slope (%)	Upper Area (ha)	Lower Area (ha)	Total (ha)	Percentage (%)	Major Vegetation
CnB	1-2	164	-	164	2.3	paddy rice
CnC	2-3	54	-	54	0.7	paddy rice
CnD	3-5	62	-	62	0.9	paddy rice
CnE	5-7	54	-	54	0.7	grassland
Sub-total		334	-	334	4.6	
UbB	1-2	96	2,271	2,367	32.4	paddy rice, grass-land, coconut field
UbC	2-3	102	1,313	1,415	19.4	
UbD	3-5	104	2,059	2,163	29.6	grassland, coconut field
UbE	5-7	64	957	1,021	14.0	grassland
Sub-total		366	6,600	6,966	95.4	
Total		700	6,600	7,300	100.0	

Note: Cn: Canlangit soil series
Ub: Ubay soil series
B.C.D.E: slope grade of topography

A total of 7,300 ha of land in the Project Area was classified by the criteria of the modified specification for land classification, which has been adapted to the study of irrigation project conducted by NIA. The Project Area was largely classified into two land category, namely non-arable lands with about 300 ha and arable lands with about 7,000 ha. About 55 percent of arable lands consist of moderately suitable land for irrigated paddy rice production (2R) and remainder is classified as the marginally suitable land for irrigated paddy rice production (3R) as shown below;

Land Classification in the Project Area

(unit: ha)

Description	Moderately Suitable Land(2R)	Marginally Suitable Land(3R)	Total
Upper Area			
Arable land	364	230	594
Beneficial area	348	172	520
Project area			700
Lower Area			
Arable land	3,489	2,918	6,407
Beneficial area	2,970	1,830	4,800
Project area			6,600
Whole Project Area			
Arable land	3,853	3,148	7,001
Beneficial area	3,318	2,002	5,320
Project area			7,300

As shown in the above figures, almost all arable land in the Project Area will be developed into paddy field except some portions having topographic limitation in class 3R lands. In the Upper area, 96.9 percent of class 2R and 57.8 percent of class 3R land have been developed into paddy field with poorly shaped and relatively small size plots. On the other hand, only 24.6 percent of class 2R and 6.3 percent of class 3R lands have been used for paddy field in the Lower area. Consequently, remaining about 4,900 ha of existing grassland, 2,300 ha in class 2R, and 2,600 ha in class 3R can be developed into paddy fields, depending on their location and sloping.

Poor drainage paddy fields were found in depressions or lowlying portions throughout the area. This poor drainage seems mainly due to the presence of weathering shale and sandstone layer (from 1.5 to 2.0m from the surface). Therefore, adequate drainage system would be needed in those portions.

Under these present conditions the soils in the Project Area are considered to be blessed with the potentiality of high yield of paddy, as a result of the survey conducted. The betterment

of paddy cultivation practices accompanied by application of fertilizers and organic matter for soil amendment and the construction of on-farm irrigation and drainage facilities etc. will work out the potentiality under the blessed natural conditions.

The detail studies based on the said survey are shown in Appendix 3B-5.

4. Earthquake

Since Bohol Island is located in a part of the Circum Pacific Earthquake Zone, it is naturally required to pay a careful consideration on the effect of earthquake.

According to the data collected by the PAGASA (Philippine Atmospheric, Geophysical and Astronomical Services Administration), the scale of earthquakes around Bohol Island is mostly less than magnitude six and the type of earthquakes is shallow or intermediate. The strongest earthquake around Bohol Island is recorded on 16 November, 1965 with a magnitude of 5.3, however, there is no significant epicenter in Bohol island.

From the above-mentioned earthquake conditions around the Island, it seems reasonable that the value of 0.1 will be adopted as a coefficient of horizontal seismic force in designing the dam and other major structures.

C. Irrigation and Draiange Conditions and On-farm Conditions

1. Irrigation Conditions

(a) Irrigation Area

Both the Pamacsalan and Wahig rivers have potential water sources for irrigation water purposes. However, the paddy fields in the Project Area are mainly rainfed although there presently exists some paddy fields irrigated by communal and private gravity irrigation and privated-owned pump.

Communal Irrigation

The communal irrigation systems have been planned, designed and constructed by NIA, and upon completion, their operation and maintenance are to be entrusted to the irrigators' associations.

The communal irrigation areas in the Project Area are located only in the upper area developed along the Wahig and Pamacsalan rivers, and these systems serve about 370 ha during both wet and dry seasons covering eight irrigation areas ranging from 15 ha to 130 ha in acreage, of which water for irrigation is diverted from the rivers by permanent concrete dams or brush dams made of cobble stone. No communal irrigation system exists in the lower area.

Private Pump Irrigation

In order to serve the relatively highland in the Project Area, the pumping irrigation is privately carried out along the Wahig and Pamacsalan rivers. Small size pumps are used for this purpose. And the total pump irrigation area is about 90 ha covering 16 places in the Project Area.

FSDC Irrigation

The Farm System Development Corporation (FSDC) is constructing the pumping irrigation system of Landing Irrigators' Services Association in Dagohoy. According to the original schedule, the irrigation water supply will be started from the end of November 1977.

Table 3C-1, in Appendix 3C-1 outlines the above-mentioned three present irrigation systems in the Project Area.

(b) Irrigation Facilities

Since one communal irrigation system has at least one or two intake dams made of concrete or cobble stone, numerous dams have been constructed in the whole communal irrigation areas at the upstream of the Wahig and Pamacsalan rivers, but these facilities including irrigation canals are old, and have been already decrepit. Therefore, the

improvement of these facilities by integrating them will be needed for rationalized water management to expand the service area for increased agricultural production.

(c) Available Irrigation Water and Water Use

To analyze an available irrigation water for the Project Area, the long term run-off analysis was made by applying the tank model for 22 years from 1956 to 1977, based on the observed data at Pamacsalan. The following table shows the average water quantity available for irrigation at the communal irrigation site and the used water for irrigation for the said year. (See Table 3C-2, in Appendix 3C-1)

(unit: MCM)

Item	Average Run-off	Used Water
Wahig basin	33.9	2.7
Pamacsalan basin	40.5	1.4
Total	74.4	4.1

According to the above-mentioned analysis, an annual water use for irrigation amounts to 4.1 MCM, while an annual run-off discharge is estimated at 74.4 MCM.

(d) Irrigation Conditions

Even in the communal irrigation areas of about 370 ha, which is equivalent to only seven percent of the arable land of 5,320 ha, no systematic water distribution are provided to convey water to the terminal areas, and so-called continuous flowing irrigation has been practiced for both the wet and dry season cultivations. On the other hand, almost all paddy fields are relying upon rainfall throughout the year, which results in poor production of crops.

Under the circumstances, the water resources development as well as the provision of systematized irrigation systems inclusive those of the on-farm level are pre-requisite to materialize the double cropping with high yield varieties in the newly reclaimed area under the Project.

2. Drainage Conditions

(a) Drainage Systems

No drainage system is provided even in the upper area where the communal irrigation is undertaken throughout the year. In the lower area, lowlying depression areas presently utilized as rainfed paddy fields and creeks play a role of drainage canals to drain run-off discharges. The major creeks in the lower area are the Malitbog and Camanaga creeks with dendritic conditions, and they are mostly connected to the Wahig river. The total length of the creeks is about 100 km in the Project Area.

These creeks have bottom slope of 0.5 to 0.8 percent, however, their capacity to drain the discharges is insufficient, so some poor drainage condition can be seen at a part of the Project Area.

(b) Drainage Conditions and Resulting Damage

Since the Project Area is located on the undulated hilly land with land slope of 1/10 to 1/100 on an average, no drainage damage on agricultural products can be seen even in the wet season. However, according to the data obtained at the Office of the Highway District Engineer, the Second Engineering District, Guindulman Bohol, the maximum flood damages including those of agricultural production and public facilities such as roads and bridges in the five municipalities related to the Project Area amounted at US$2.3 million, which was caused by the flood on November 19, 1964.

3. On-Farm Conditions

(a) Present Farm Fields in the Project Area

Present farm fields in the Project Area, mainly in the communal irrigation area, have been hardly equipped with terminal farm roads, irrigation and drainage canals because the traditional paddy cultivation with plot-to-plot irrigation have been performed under relatively steep topography. Farm practices and transportation of agricultural input and output are mostly made by manpower or carabao. For daily farm

practices farmers mutually enter into the other farmers' farm fields on foot.

Farmers are very eager to reclaim new paddy field in the lower area, but the shortage of funds and irrigation water has prevented them from doing it in full scale. However, a few paddy fields newly reclaimed recently by the landowner are seen in the Project Area, which are reclaimed in accordance with the assistance of the Government.

(b) Size and Shape of Farm Fields

An average size of existing farm plots range from 100 sq.m to 2,000 sq.m, and their shape are very pseudomorphic due to undulating topography.

D. Present Agriculture

1. Present Land Use

The Project Area of 7,300 ha consists of the cultivated areas of about 2,230 ha and the uncultivated areas of 5,068 ha, and the cultivated areas are subdivided into two land categories, about 1,530 ha of paddy fields and about 700 ha of upland fields. The uncultivated area are cogon, homestead land, roads, canals and others. (See Table 3-1)

Out of these cultivated areas, the paddy field, consisting of about 470 ha of irrigated paddy fields and 1,060 ha of rainfed paddy fields, occupy the 69 percent of the total cultivation area. The irrigated areas of 374 ha are being served by communal irrigation systems which are found in the upper portions and 74 ha served by privately-owned pump irrigation are scattered in the whole Project Area.

On the other hand, the rainfed paddies are mainly developed in the lower portions between rolling highlands in the lower area except for the small portions in the upper area. Adjacent to the rainfed paddies, the elevated upland fields planted with upland rice, corn, cassava, sweet potato, coconut, banana etc. for home consumption are located.

Table 3-1 Present Land Use

(unit: ha)

Area	Municipality	Gross Area	Cultivated Area: Paddy Fields: Irrigated 1/	Paddy Fields: Rainfed	Paddy Fields: Sub-total	Upland Fields: Upland Rice	Upland Fields: Other Crops 2/	Upland Fields: Coconut & Banana	Upland Fields: Sub-total	Others: Grass Land	Others: Village Site	Others: Others 3/	Others: Sub-total
Upper Area													
Wahig Basin	Sierra Bullones	441	264	65	329	-	-	17	17	36	14	45	95
	Pilar (1)	82	-	18	18	-	3	-	3	52	1	8	61
Pamacsalan Basin	Pilar (2)	177	130	9	139	-	-	-	-	-	8	30	38
Sub-total		700	394	92	486	-	3	17	20	88	23	83	194
Lower Area													
	Pilar (3)	2,215	11	356	367	55	99	113	267	1,537	11	33	1,581
	Dagohoy	2,881	51	426	477	176	83	22	281	2,041	39	43	2,123
	San Miguel	534	-	83	83	-	11	-	11	420	12	8	440
	Alicia	970	12	103	115	56	27	42	125	683	32	15	730
Sub-total		6,600	74	968	1,042	287	220	177	684	4,681	94	99	4,874
Total		7,300	468	1,060	1,528	287	223	194	704	4,769	117	182	5,068

Note: 1/ Consist of communal irrigation area (374 ha) and privately-owned pump irrigation area (94 ha)
2/ Consist of corn, cassava, sweet potato and etc.
3/ Consist of roads, creeks, canals and etc.

In the lower areas of the Project, there are plenty of cogon areas which are left as idle land due to non-existence of irrigation water sources.

Most of the rainfed paddy field are cultivated twice a year under even distribution of rainfall throughout the year except for the short periods in the dry season, so that the paddy yield in the areas is quite low, especially the crops planted during dry season. Severe droughts are found out about twice every 10 years during dry season cultivation, according to the meteorological data obtained.

2. Farming Status

(a) Farm Size

The present farm household and population in the Project Area of 7,300 ha amounts to 2,069 households and 12,200 persons, respectively. These farmers belong to 5 municipalities and 24 barrios and has average farm size of 1.5 ha which was studied by the NIA in 1974 as shown in Table 3-2. It will be found that the farm households possessing the land less than 2.0 ha is amounted to be 67 percent of the total farm households, and their area is equivalent to 25 percent of total farm land in area. On the other hand, the farm households possessing the land more than five hectares is amounted to be seven percent of the total farm households and 45 percent for the said area with an average size of 10.7 ha. (See Table 3-2)

As mentioned in the previous paragraph, "Land Use", the 65 percent of the Project Area (7,300 ha) is occupied by grassland (4,769 ha). These land could be said to be cogon lands, and the numbers of land owner of them are not clear. However, the Land Resources and Economic Division, NIA has surveyed the land use of the present farm land based on the tax book prepared by the municipality assessors' office at 14 Barrios in five municipalities. From the result, holding status of cogon land in the Project Area is revealed that an average size of cogon land per owner is 4.8 ha. The land owners possessing the cogon land more than seven hectares have the land of 64 percent of the total

Table 3-2 Present Distribution of Farmers and Area by Tenure of Operation and Farm Size

(unit: %)

Farm Size (ha)	Full Owner		Part Owner		Share Tenant		Lease		Total		Average Size (ha)
	No. of Farmer	Area	No. of Farmer	Area	No. of Farmer	Area	No. of Farmer	Area	No. of Farmer	Area	
Less 1.0	11.4	2.3	3.1	0.7	18.2	3.7	2.8	0.6	35.5	7.3	0.45
1.00 - 1.99	12.5	7.2	2.5	1.5	15.4	8.9	0.8	0.4	31.2	18.0	1.28
2.00 - 2.99	6.4	6.5	1.8	1.8	5.6	5.5	0.4	0.5	14.2	14.3	2.23
3.00 - 3.99	2.8	4.0	0.6	1.0	2.7	3.8	0.1	0.1	6.2	8.9	3.21
4.00 - 4.99	2.2	4.2	0.5	0.8	0.9	1.8	0.1	0.2	3.7	7.0	4.23
5.00 and over	4.3	22.2	0.7	2.2	4.2	20.1	-	-	7.2	44.5	10.73
Total	39.6	46.4	9.2	8.0	47.0	43.8	4.2	1.8	100.0	100.0	

Source: Preliminary study, 1974 LRED, NIA

The survey was carried out at the 20 Barrios within the municipalities around the Project Area and its vicinity. Total farmers are 1,840 and total areas are 4,080 ha.

land and their average size is 13.8 ha, as shown below;

Distribution of Cogon Lands Owner Possessing more than Seven hectare

	7.0 - 9.9ha	10.0 - 14.9ha	15.0 - 19.9ha	20.0 - 29.9ha	30.0 - 49.9ha	50.0 - 69.9ha	70.0ha & over	Total
Number	30	53	22	13	2	1	0	121
Percent	24.8	43.8	18.2	10.7	1.7	0.8	-	100

Note: Total areas surveyed: 2,597 ha
Numbers of owner: 544 persons

Cogon land owners consist of those with and without cultivated land. The latter possesses the land equivalent to 27 percent of the total land and of which an average farm size is 4.8 ha these owner would be grown into new farmers after completion of the Project. Such new farmers would be amounted to be 220 households.

(b) Land Tenure

Department of Agrarian Reform has officially announced that the issue of land transfer certificates on tenant land parcels which are held by landowner possessing the land more than seven hectares was completed in August 1976. After that, the transfer of contract from the share rent system to the fix rent system is in progress in the tenant's land less than seven hectares.

According to the information obtained from the DAR, out of total municipalities of 48 in Bohol island, 12 municipalities have been listed up as the municipalities already completed on the Tenants Issued Land Transfer Certificates. In these areas, Pilar, Dagohoy and San Miguel concerned to the Project and Carmen, Ubay, Candijan and Guindulman adjacent to the Project Area are included. This means that the land reform is in progress under fairly good conditions in the rural areas. In Table 3 - 2, the percentage of landowner and share tenant represents to be 46 and 44 percent respectively. Under these conditions of land reform, the number of farmers possessing the land over than five hectares and share tenants will be decreased owing to the land reform.

The following table indicates farm-households classified by the sharing ratio of product between landowner and tenant, and from the table it is revealed that the most frequent sharing ratio between the landowner and tenant is 30 to 70 percent.

Tenancy Sharing Arrangement

Sharing Arrangement		No. of Farm Household			
		Irrigated Paddy		Rainfed Paddy	
Landowner (%)	Tenant (%)	First Crop	Second Crop	First Crop	Second Crop
25	75	1	a/	7b/	6
30	70	1	1	13c/	11
40	60	-	-	1	1
50	50	2	2	5	5
Rent free		-	-	-	-
Total		4	3	26	23

Source: Agro-Economic Survey, NIA, 1977

a/ No second crop b/ include one upland rice farm
c/ include two upland rice farm

(c) Taxation

The taxation consists of income tax and real property tax. The former is tax imposed on the net income realized in one taxable year. Net income means gross income less allowable deductions. According to the tax table, tax due are decided such that; the net income less than 2,000 pesos is of 3 percent and the net income of 2,000 pesos through 4,000 pesos is of 60 pesos plus 6 percent of excess over 2,000 pesos.

Amount of exemptions allowed is 3,000 pesos for person married or head of family. Then, in the Project Area, subject farmer to allow exemption of tax will be almost neglected.

Real property tax is tax on buildings and machines. At present, big farm machine is not almost introduced. But in future above two kinds of taxes would increase after completion of the Project.

3. Present Cropping Pattern and Crop Production

Irrigated paddy fields are cultivated with high yielding varieties (HYV) twice a year, that is, the wet season cropping from June to October and the dry season cropping from December to April are carried out as shown in Figure 3-1.

In the rainfed paddy fields, the same cropping calender as that of irrigated area is applied at present and their varieties is 90 percent of high yielding variety and 10 percent of traditional variety.

The cropping schedule varies every year due to unstable rainfall, which makes the lag period last for two months. Attributed to this natural phenomena, yields of the rainfed paddy are variable.

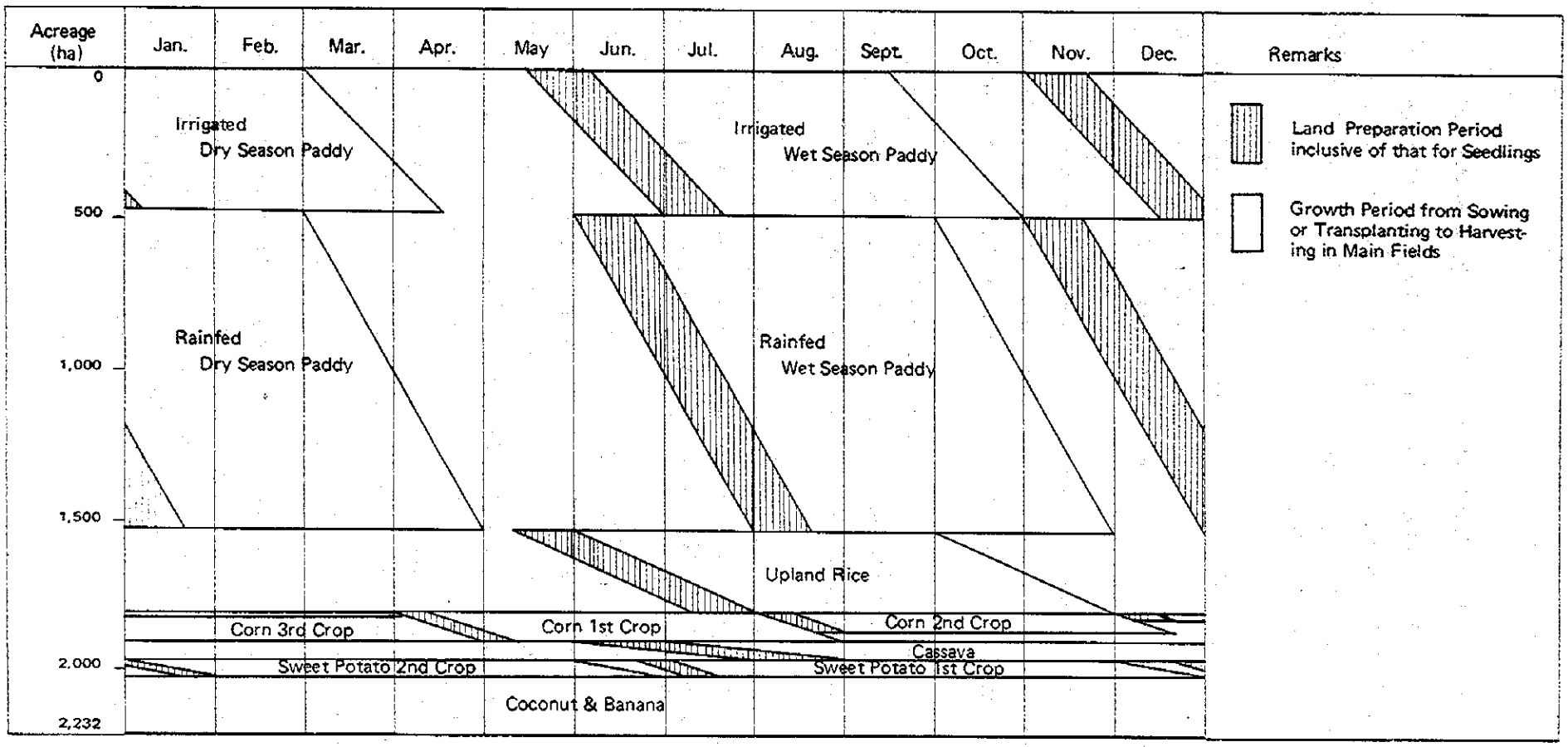
Traditional rice variety called "Lubang" is mostly seeded directly to the upland fields once a year. As for the other upland field crops, they are generally grown once or twice a year.

The total production of paddy including upland rice in the Project Area is 5,214 tons, and another upland crops production is 278 tons. (See Table 3D-5, Appendix 3D-1). The cropping intensity is 174 percent.

The average yield of irrigated, rainfed and upland rice during the wet and dry seasons is 2.3, 1.6 and 0.8 tons per hectare, respectively. The weighted average yield per hectare of the planted area for the three kinds of rice is 1.7 tons, which is almost the same as the national average of 1.6 tons for the past five years. The low yield even in the irrigated area is due to the insufficient irrigation water supply with unimproved facilities of present irrigation systems, especially during the dry season.

On the other hand, the average paddy yield with Masagana 99 Program in both wet and dry seasons is 3.2 tons per hectare in the irrigated area and 2.3 tons per hectare in the rainfed area. (See Table 3D-6, Appendix 3D-1) Higher yield is attained by outstanding

FIGURE 3-1 PRESENT CROPPING PATTERN



farmers, seed production farmers and demonstration farms, in the Project Area and its vicinity. (See Table 3D-7, Appendix 3D-1) Farmers in the Project Area have the good potentiality to attain these high yields, if enough irrigation water is supplied.

4. Input Supply

The Masagana 99 Program in the Project Area has been extended in the area of about 50 percent for the irrigated paddy cultivation and 10 percent for the rainfed paddy cultivation. One half of which is composed of areas with credit and the remaining half without credit.

Rice seeds of about 145 tons are used in the Project Area. About 90 percent of this tonnage is high yielding varieties. The latest varieties have already been used in about 45 percent of the irrigated paddy fields. In upland and rainfed paddy fields, few farmers keep on renewing their seeds varieties to the latest ones, resulting in non-uniform growth height of plants with low yields. (See Table 3D-9, Appendix 3D-2).

Although relatively high rate amounts of fertilizers, about 30 kg of nitrogen, has been applied for the irrigated paddy, and only small amount has been used for the rainfed paddy (14 kg) and upland paddy (6 kg). No insecticide has been applied for the upland crops. (See Appendix 3D-2)

Many farmers cannot afford to apply adequate amount of fertilizer, insecticide and other chemicals due to the low yield and low income.

5. Farm Labor Balance and Farm Mechanization

An excessive numbers of labor can be found in the Project Area at present, because a primitive farming has been practiced in the existing cultivated area. However, only small numbers of farm machineries are employed, that is, a few percent of land preparation works are carried out by mechanized farming and about 90 percent of paddy threshing works by means of pedal thresher in small scale.

The estimated annual labor requirements in the Project Area are about 283,400 man-days for the whole year, which is equivalent to the only 25 percent of available labor sources in the area. Furthermore, even in the busy season during the paddy cultivation, the excess labor is estimated at about 60 percent of the labor source. (See Figure 3D-1, Appendix 3D-3) Even under these circumstances, a plenty of labor in the Project Area and its vicinity is accustomed to be hired for the operations of paddy transplanting and harvesting, but the excess labor will be increased during the spare time of labor demand in the crop growing stage. In future, proper procedures to cope with these conditions should be undertaken to have a chance of utilizing such idle labor.

6. Animal Husbandry

Of the major livestock and poultry in the five municipalities concerned, carabao has the biggest share of approximately 58 percent in the total values. It has proven its usefulness to farmers especially in farm cultivation. About 90 percent of paddy farmers own averagely one work carabao in the area. (See Table 3D-15, 3D-16, Appendix 3D-4)

However, a record shows that the number of carabao is decreasing in the Project Area due to carabao disease, and in addition, due to the fact that farmers are forced to sell their carabao to pay their various loans.

The most prevailing disease is hemorrhagic septicemia which is reported to affect 25 percent of the carabao in the Project Area. Female carabaos suffering from the disease cannot bear calf carabaos.

Presently, the Government moves to maintain or increase carabao giving yearly vaccination for all possible diseases, preventing killing of youngs and workable carabaos, and providing improved pastures, etc.

7. Farm Economy

Farm economy in the Project Area, in general, is associated with the size of farm, size of paddy field, especially irrigable area tenure system. Staff of Land Resources and Economics Division, NIA surveyed the farm economy on the selected 60 farmers in August 1977. The results are summarized in the following table.

Result of Farm Management Survey

Description	Values
Number of sample:	60 farmers
Average farm size:	1.75 ha (100%)
Paddy field:	
Irrigated	0.14 ha (8%)
Rainfed	1.04 ha (59%)
Number of family:	5.8 persons
Paddy production:	69.0 cavans
Gross farm income:	3,799 pesos
Palay	3,450 pesos
Other crops	285 pesos
Other works 1/	64 pesos
Non-farm income:	423 pesos
Gross income:	4,222 pesos
Production cost	974 pesos
Crops	570 pesos
Food	8 pesos
Harvesters/Threshers 2/	396 pesos
Farm income:	3,248 pesos
Rent 3/	452 pesos
Net income:	2,796 pesos
Living allowance:	2,445 pesos
Surplus income:	351 pesos

Note: 1/ inclusive of hired wage to other farm, lease charge of animals and farm machineries to others.
2/ payment in kind.
3/ Full owner of 23 samples - 0 pesos
Part owner of 12 samples - 677 pesos
Share tenant of 22 samples - 800 pesos
Lease tenant of 3 samples - 452 pesos

From the result of the survey, the following are summarized:

a) An average farm size is 1.75 ha in the sample area, while that in the Project Area is 1.5 ha on average, and the farmers profit a surplus income of 350 pesos per annum. But if these farmers

did not have non-farm occupation, they would get negative surplus income.

b) Surplus income profited from the farmer having the land less than one hectare is negative values.

c) Paddy field of which an average size is 1.75 ha occupies the 67 percent of farm land, and products from paddy cultivation occupy 91 percent of the total gross income.

d) Ratio of rent to land lord is of 13 percent on an average farmer, and 32 percent in share tenant and 20 percent in lease tenant.

e) Living allowances per household with an average family 5.8 persons are amounted to be 2,445 pesos on an average, but in comparison with the tenure system, those of full owner with an average family of 5.3 persons and share tenant with 6.5 persons are amounted to be about 3,700 pesos and 1,500 pesos respectively. Thus, the tenure system causes a difference more than two times on living conditions. (See Table 3D-17 to 3D-24 in Appendix 3D-5)

f) Full owner sell about 45 percent of total palay production, but share tenant can sell off only 15 percent.

g) Production cost ratio to gross crop income show 26 percent in average farmer. Rate of full owner is 30 percent and share tenant is 18 percent.

8. Processing and Marketing of Farm Products

The agricultural economic survey on marketing in the Project Area revealed the present status of production, collection, processing, transportation and sale of the farm products in resuming the following:

Production, Collection, Processing, Hauling and Sale of Farm Products in the Project Area

Crops	Production (ton)	Marketing
Paddy	5,214	Most of paddy produced and consumed in the Project Area and its vicinity has been processed in milling factories in the relevant areas and some of the rest has been collected by merchants to be hauled and processed for consumption in Tagbilaran or Cebu and others in Mindanao.
Maize	87	Treated same as above.
Cassava	69	After dried up and sacked, the products are sold to merchants who bring them to Tagbilaran for processing.
Sweet potato	72	Some have been in the market or sold to merchants, although mainly consumed in farmers home consumption.
Coconuts	50	After processing to copra, the products are exported via Tagbilaran

Note: Findings in agricultural economic survey are shown in Table 3D-25 in Appendix 3D-6.

The facilities of milling, storage and transportation in the Project Area are shown in the following table which suggests no trouble/bottleneck in their capacity to meet the requirements. The National Grains Authority (NGA) office in Tagbilaran controls these facilities in giving guidance on their operation and maintenance.

Milling, Sotrage and Transportation

Items	Number of facilities	Capacity
Milling	25	88.9 ton/day
Storage	9	1,200.0 ton
Transportation	13	48.5 ton

Note: The details are shown in Table 3D-26 in Appendix 3D-6.

9. Agricultural Credit

The agricultural credit system was initiated in 1908 under the American Administration and has taken a long and hard time to be firmly established as it is now.

The banks and organization that are currently handling the agricultural credit are the Agricultural Credit Administration (ACA), the Philippine National Bank (PNB) and the Rural Bank (RB).

These banks and organization have been giving credits to farmers mainly according to the programs of Masagana 99 (Rice production increase) and Masagana Maisan (Maize production increase) that have been undertaken by the Bureau of Plant Industry (BPI) and the Bureau of Agricultural Expensions (BAEx).

The credits have been effectively offered to farmers for their purchases of seeds, fertilizers, agri-chemicals, farming machinery and domestic animals in one package deal with rendering technical guidances by the BPI and the BAEx. The credits are specified into two categories; the short-term (six month on condition of repyment at harvesting) for purchasing seeds, agri-chemicals and paying for wages of temporal employees, etc, and the medium- or long-term credits (repayment at three to 10 years) for construction of warehouses, purchase of farming machinery, domestic animals, cost for land improvement, etc.

The farmers have received the credits on the individual basis as well as Samahang Nayon basis according to the programs of Masagana 99 and Masagana Maisan under the guidance of the BPI and the BAEx. The credit is provided on terms and conditions of the annual interest by 12 percent (Net 14 percent including handling charges) without any mortgage and not exceeding the amount of 1,600 pesos per hectare.

In the Project Area, there has been a compact farm established

in San Jose of Sierra Bullones, functioning as organization for receiving and repaying the credits under the program of Masagana 99.

Generally speaking, however, the shortage of credit funds, poorly-formed farmers' organization and arrear of repayment have prevented the farmers from timely crediting the necessary amounts.

The current status of local finance in the Project Area is shown in Table 3D-29 and 3D-30 in Appendix 3D-6. The agricultural economic survey revealed that the farmers have been suffering from poor farm management due to shortage of funds available by the reasons quoted below.

- Purchase of fertilizers
- Payment for wages
- Decreased income from poor harvesting by years
- Purchase of domestic animals
- Provision of new irrigation facilities
- Shortage of cost of living

The farm managerial funds have been borrowed from land owners, Rural Banks and credit unions at the average annual interest of 20 percent. The shortage of such funds has been a bottleneck to improve the poor farm management as being shown by the fact that carabaos kept by farmers decrease in number when the due time comes for repayment of the credit under Masagana 99.

10. Research on Paddy Cropping and Extension Services

The agricultural extension services in Bohol Island have been carried out in cooperation works by the BPI and BAEx. The BPI staff have rendered technical guidances and extension services mainly in cropping of paddy, cassava, fruit trees, etc. and the BAEx staff in cropping of maize, pulses, vegetables, etc.

The BPI office has been active in guidance and extension of paddy cropping techniques and distribution of seeds of improved varieties,

fertilizers, agri-chemicals including know-how in their application along with the well-contemplated package program with credit covered by Masagana 99. The devoted services in the lines have been steadily producing good effects.

The BAEx office has been giving technical guidances to farmers for maize production increase with target along with the Masagana Maisan on the basis of proposed cropping acreage of 142 ha, average yield of 32 cavans (1.6 ton/ha), DMR2 varieties (local varieties) and credit of 500 pesos per hectare.

Each Barrio in the Project Area provides Farmers' Association (six units), Home Makers Club and Rural Youths' Club through which every guidance and instructions can penetrate to individual farmers.

Figure 3D-2 in Appendix 3D-6 illustrates the organization of the BAEx.

Both the BPI and the BAEx complain about agricultural low productivity in the following views;

- Shortage of fertilizers and agri-chemicals
- Poor provision of irrigation and drainage facilities
- Unfavourable soil conditions
- Farmers evasion of new high yielding varieties

The following is the existing organizations that are executing agricultural experiments or researches.

Agricultural Experiment Farm:	BPI Experiment Farm (Ubay San Pascul)
Animal Husbandry Experiment Farm:	A and B Breeding Stock Farm (Ubay San Pascul)
Seed Farm:	Seed Farm under the guidance of BPI (Individual farms)
Agricultural College:	Bohol Agricultural College

11. Farmers' Organization

The existing farmers' organizations include Irrigators Association, Farmers' Association for technical improvement, Samahang Nayon (Barrio Association), Kilusang Bayan (Cooperative), etc. the respective structures and activities of which are explained below.

(a) Irrigators' Association

Communal Irrigaton System

There are eight communal irrigation areas along the Wahig and the Pamacsalan rivers in the Project Area, employing the irrigation by water intake from the said rivers, though in the small-scale. (Refer to Table 3D-33 in Appendix 3D-6)

The operation and maintenance of facilities are carried out by compulsory services of the farmers concerned, and no water charges have been collected for the purpose.

Pump Irrigation System (Irrigators' Association)

There exist 16 pumping irrigation facilities privately provided in the Project Area. (Refer to Table 3D-34 in Appendix 3D-6) Individual farmers and several farmers in cooperation have installed these facilities on credits from the Development Bank and tried to develop new paddy fields and necessary irrigation facilities.

(b) Farmers' Association for Technical Improvement

For promotion of Program of Masagana 99 and Masagana Maisan, the farmers in the irrigation areas have cooperated with the BPI and BAEx staff and established the Farmers' Association that gives individual farmers the technical guidances for agricultural improvement and production increase.

On top of the above, the Home Makers Club has been trying to improve the living conditions, the family planning and sanitary

environment, and furthermore, the Rural Youths' Club has been functioning for regional development and guidance of the rural youths.

(c) Samahang Nayon and Kilusang Bayan

According to the Presidential Decree 175, the Department of Local Government and Community Development (DLGCD), as the executing body of the Government, has made promotion of establishment of Samahang Nayon (Barrio Association) in every barrios, which provides various functions such as development of rural community, promotion of campaign for Masagana 99 and Masagana Maisan, provision of systems to receive credits, and frame works for establishment of agricultural cooperative. (See Table 3D-34, Appendix 3D-5)

No cooperative activities have been carried out in the Project Area due to absence of the organization of Kilusang Bayan; however, there seems to be a sign for movement to organize the Kilusang Bayan in the Project Area in the very near future.

E. Electric Power

1. Present Condition of Supply and Demand

In the Project Area, there is no Public Electric Power Supply System. Although there exist some houses equipped with small private electric generators in the area, their numbers are limited only to 0.6 percent of all houses existing in the report of NEDA in 1975. Kerosene lams are usually used for home lighting and for equipment which requires power, internal combustion engines are applied.

In the area facilities equipped with the internal combustion engine for their power supply are as follows:

Facilities	Power	No.
Irrigation pumping plant	10 - 15 HP	16
Rice mill plant	10 HP	22
"	40 HP	1
"	15 HP	1
"	20 HP	1

As mentioned above, the area where electric facilities can be applied is extremely limited in the Bohol. There are seventeen electrified Municipalities, but the rest of the thirty Municipalities remains unelectrified. Even for electrified Municipalities, the electric distribution line do not reach to their suburbs. Figure 3E-1 shows the electrified area in the Province of Bohol. (See Appendix 3E-1)

Electrification is making gradual progress by NPC or NEA. Tagbilaran City which requires the largest electric power load, Loay, Alurquerque and Belayon receive their electric power from the Loboc hydro-power station. Distribution lines from the Loboc power station (13.2 KV) run from Loboc, along national highway No.3 and finally to Tagbilaran city. Meanwhile distribution lines from the Tubigon diesel power station cover 11 Municipalities as follows:

i) Calape, Loon, Maribojoc, Cortes, along the Eastern coast.

ii) Branched from Calape, to San Isidro, Anlequera, Bullihan.

iii) For the northern area of Tubigon, from Clarin to Inabauya.

iv) Branched from Clarin to Sagbayan.

The power station facilities which supply electric power to these Municipalities are listed as follows:

Existing Power Station	Capacity
Loboc hydro-power (NPC)	1.2 MW (0.4MW x 3units)
Tagbilaran electric Co. (Diesel)	0.9 MW
Tagbilaran diesel (NPC)	11 MW (5.5MW x 2units)
Tubigon diesel (NEA/BOHECO)	3.5 MW (1MW x 1unit) 0.5MW x 5units)

Loboc power station is operated continuously for 24 hours and rated as 1.2MW in the rainy season and 0.9 MW in the dry season as base load supply. The largest demand for power is Tagbilaran City and demand is estimated to reach 1,440 KW in 1978, at which time the present power plant capacity will become over loaded. Electric power supply

hours from Tubigon diesel power station are limited to eight hours from 16.0 to 24.0 each day. The demand in 1978 is estimated to reach 970 KW (2,115 MWH) and the power station has enough capacity for the demand.

The extension of the 69 KV transmission line is under construction in provision for the start-up of the NPC Tagbilaran diesel power station. In this work, one line extends to Garicia-Hernandes on the southern coast and the other line comprises the combination line with the Tubigon BOHECO power station. These transmission lines are expected to be equipped with respective sub-stations.

2. Organization of Electric Power Industry

In the Philippines, the NPC (National Power Corporation) and the NEA (National Electrification Administration) have charge of electricity supply as public corporations and an executive agency in the sphere of electric power industries.

NPC mainly has charge of the power plants of relatively larger capacity, such as, hydraulic, thermal, atomic and geothermal power plants and main transmission lines. NEA, on the other hand, has charge of power plants of smaller capacity and branch lines, such as distribution lines (13.2 KV), secondary sub-station etc. For final distribution lines to users, private electric companies take charge and NEA supervises them.

In Bohol, Loboc and Tagbilaran (now under construction) power plants are incharge of NPC. Tubigon Power Plants are incharge of NEA. Tagbilaran Electric Company and BOHECO (Bohol Electric Cooperative, Inc.) are incharge of the power supply to final user.

3. Power Demand Trend

Power demand in Bohol rather trends toward agriculture than industries and the main demand for agriculture will be pumping facilities for irrigation and rice processin facilities. Besides, usual

refrigerators and air conditioners.

The trend of power demand in Pilar, Sierra Bullones of the Project Area, investigated by NPC in 1977, is shown in Table 3E-1 in Appendix 3E-1. These areas are mainly situated in agricultural areas. The main power demand therefore will be lighting of farm houses and power for rice mills and pumping facilities for irrigation. Power demand for one farm house is reported to be 30 KWH per month as a mean value.

As the estimated values by the NPC exclude the factor of economic growth by the irrigation effect, a more accurate estimation including this factor shall be made, and furthermore, the demand of power consumed by the newly constructed facilities such as dam, diversion dam, project office and operation center, which will be operated after the completion of the project, shall be taken into consideration.

The above-mentioned demand is estimated to be 40 KW, considering the 30 percent demand factor for the rated 120 KW capacity.

The increase of agricultural production by irrigated farming will serve as an incentive factor for the growth of farm produce industries and promote the conversion from the usage of internal combustion engines which need troublesome maintenance to the introduction of electric motors. These conversions will take place not only in the Project Area but also in its vicinity.

Taking all factors into consideration, the growth of power demand for the Municipalities of Pilar and Sierra Bullouness in the Project Area is estimated at about 540 KW in the year 2,000 while that in 1979 is 65 KW. (See Table 3E-1 in Appendix 3E-1)

4. Power Cost and Rate

The construction cost per KW for the power stations in Philippines is analyzed as follows:

Construction Cost per Kilowatt

Power station		Cost ($/KW)	Remarks (MW)
Agus V	(Hydro)	920	50
Magat	(Hydro)	1,130	-
Bulam	(Thermal)	400	18
Tagbilaran	(Diesel)	259	11

Since the construction cost per kilowatt for hydraulic power stations, in general, varies very widely because of their natural situated conditions, it is difficult to evaluate such costs in simple and general ways.

The cost of the Loboc plant, which is only one hydro-power station in Bohol, might be low because the plant is situated under better geographical conditions though the lack of enough data makes it impossible to indicate a reliable value of the construction cost.

Annual costs for the Magat (I) hydro-power station are reported as shown below;

Annual Cost of Hydro-Power Station

Description	Cost (₱ '000)
Amortization (7%, 50 years)	46,218
O & M and Replacement	2,342
Tax and Insurance (0.2%)	1,276
Total	49,836

The annual costs for the Tagbilaran diesel power station are evaluated as follows;

Annual Cost of Diesel Power Station

(unit: ₱ '000)

Description	Fixed Cost	Variable Cost	Total
Power plant			
Interest	1,285	-	1,285
Depreciation	1,081	-	1,081
O & M	469	75	544
Others	27	14	41
Administration	41	7	48
Fuel oil	-	8,786	8,786
Lubricant oil	-	394	394
Tax	-	-	-
Sub-total	2,903	9,276	12,179
Transmission line	1,618	75	1,693
Sub-station	558	20	578
Total	5,079	9,371	14,450

Source: NPC, Tagbilaran

Compared with these data, almost all costs of the Magat plant include fixed costs, even though there is a small portion of variable cost in O & M. For the Tagbilaran power plant, on the contrary, the portion of variable costs reaches to 75 percent of the annual cost and the fuel cost reaches overwhelmingly to 95 percent of the variable costs. Therefore, the prime cost for energy will be given as 0.054 ₱/KWH for Magat (I) power plant and 0.219 ₱/KWH for Tagbilaran power plant respectively, and the prime cost of Tagbilaran plant is four times more expensive when compared to the Magat (I) plant.

The rates for the sale of electricity from NPC to the utility, cooperative or non-utility in Visayas is as follows;

Demand charge:

All kilowatts of billing demand	₱ 10.0/kw/meter/month

Basic energy charge:

First 300 KWH per KW of billing demand	₱ 0.20/KWH
Next 150 KWH per KW of billing demand	₱ 0.18/KWH
Excess Kilowatt-hours	₱ 0.16/KWH

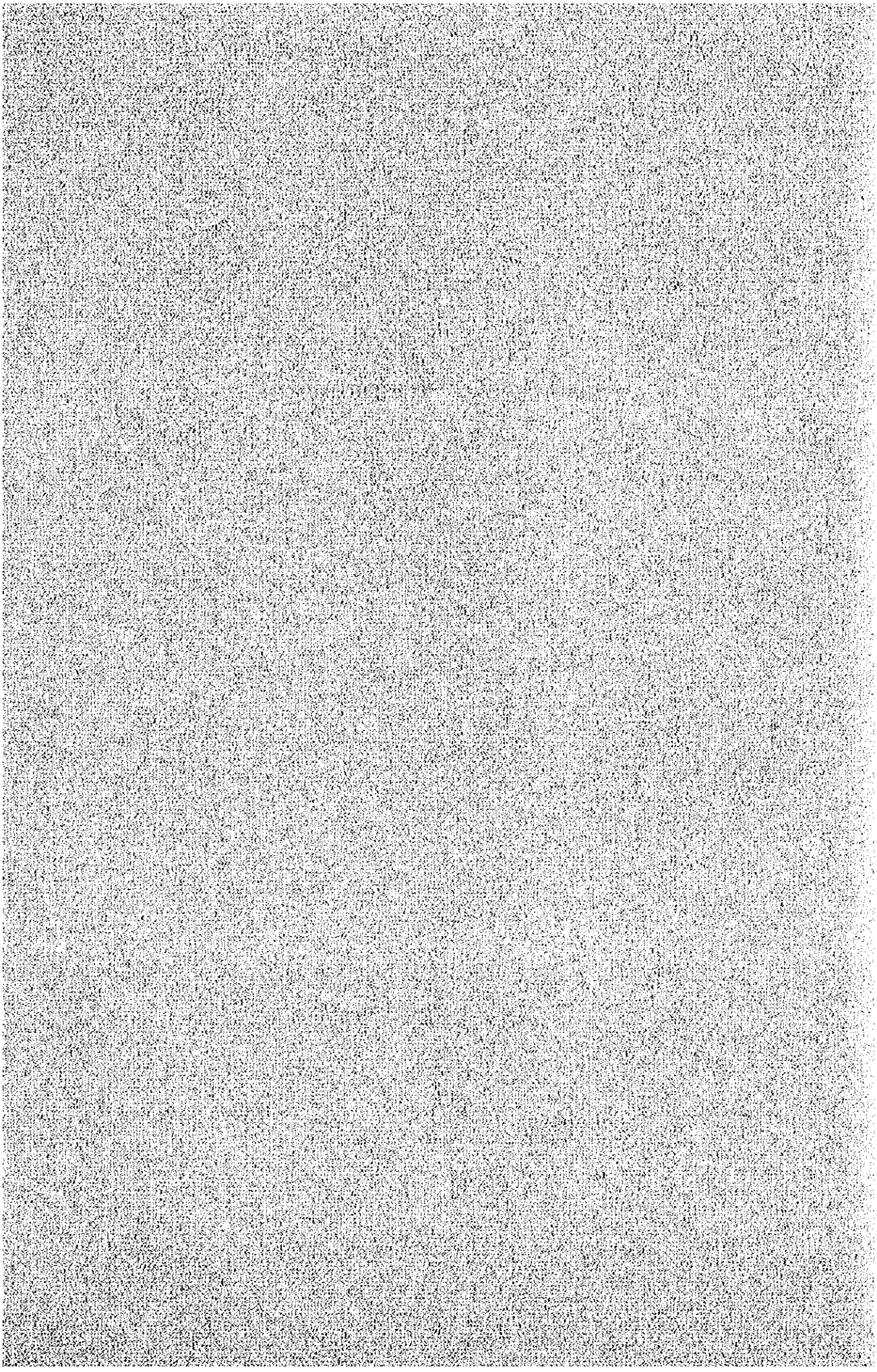
Minimum charge:

The monthly minimum charge shall be estimated based on the kilowatt of billing and contract energy.

BOHECO supplies electricity to consumer at the following rates:

Home-use rate:	up to 12 KWH	₱ 7.20
	over 12 KWH	₱ 0.70
Commercial-use rate:	up to 20 KWH	₱ 3.00
	over 20 KWH	₱ 0.75

CHAPTER IV. THE PROJECT



CHAPTER IV THE PROJECT

A. Objectives and Components of the Project

1. Objectives and Scope

The Project Area and its neighborhood have been left behind the progress up to present. Consequently, the population density is considerably lower than the average one in the Province of Bohol as a whole. There might be many reasons to be accounted in this regard, but one of the major reason will be the absence of water resources available for irrigation water under the existing conditions as well as agricultural infrastructural facilities required for rationalized farming such as irrigation and drainage canals and farm road networks of the on-farm level, which naturally results in no opportunities of employment and low farm income. Since the Project Area is blessed with natural conditions including soil, climate and topography for paddy cultivation, the potentiality of the Project Area for agriculture could be surely exploited by equipping adequate infrastructure.

The Project aims to increase agricultural production, create the employment opportunities throughout the year, and improve the living environment from the viewpoint of the rural development through the provision of assured irrigation water with improved agricultural supporting services, road system and electric power. In order to achieve the above-mentioned objectives and to get quick benefit in the whole Project Area, the following should be envisaged by phasing manner in accordance with the proposed work schedule.

i) Establishment of irrigation and drainage systems with dam for double cropping of high yield varieties and the other profitable crops;

ii) On-farm development for irrigated agriculture as well as for modernized agricultural practices;

iii) Construction of systematic road networks and rehabilitation of the existing provincial roads for transportation;

iv) Institutional arrangement and strengthening of agricultural supporting services for full development of the Project Area; and,

v) Rural community development after the implementation of on-farm development and electrification.

2. Components

The Project includes the following components:

Civil Works:

i) Irrigation and drainage: The construction of storage dam, diversion dam, and irrigation and drainage canals.

ii) On-farm development: The construction of on-farm roads, farm ditch and farm drain.

iii) Roads: The construction of road networks including rehabilitation of the existing provincial roads, etc.

iv) Hydro-power: The generating mini-hydro electric power for rural electrification.

Agricultural Development:

v) Irrigated agriculture: The introduction of new agricultural techniques with double cropping of transplanting paddy of high yield varieties under well-controlled water management.

vi) Supporting services: The provision of necessary extension and training services strengthening of input supply, credit, marketing, and agricultural processing.

vii) Institutional arrangement: The establishment of farmers organization including those for operation and maintenance and the agricultural cooperatives.

For the implementation of the above-mentioned Project Components, sufficient construction equipment should be procured, and the appropriate number of consulting engineers and experts should be recruited.

B. Project Formulation

1. Alternatives for Optimal Scale of Development

(a) Basic Conception of Alternative Studies

According to the topographical conditions as well as the geological conditions in the river basin as the surface water resource, three potential dam sites at Pamacsalan, Wahig and Bagunan rivers have been selected to have a storage function. In order to use the limited water resources as much as possible, a diversion dam at the downstream of the confluence of the Wahig and Pamacsalan rivers, named Malinao diversion dam, has been proposed.

The irrigation area is categorized into three areas of i) Pamacsalan upper area, of which potential area is 139 ha, ii) Wahig upper area, of which potential area is 490 ha, and iii) lower area which is the main irrigation area in the project with the potential area of 4,800 ha.

Comparing with the river bed elevation at Wahig dam site (EL 230) and Pamacsalan dam site (EL 190), the difference of the elevation is about 40 meters, so that it might be possible to have a trans-basin of the Wahig river water to the Pamacsalan reservoir through a trans-basin tunnel for about 5 km in length.

As for the Malinao diversion dam, it would be possible to have a storage function for about three million cubic meters by heightening the weir with gates structure though the existing communal area will be submarged in several hectares. It will be possible to play a role of an after-bay to regulate the water release for peak power generation for irrigation water supply. Also the river flow from the remaining catchment area as well as the return flow from the upper area can be regulated by the function of storage of the Malinao diversion dam.

It was found that the discharge from the Bagunan river is quite small in amount comparing with its catchment area. Therefore, the

Bagunan reservoir was considered as an after-bay function only to regulate the excess water of power generation to meet the irrigation demand.

The alternative studies could be categorized into the following cases in view of the configuration of water resources development; i) single reservoir plan, ii) multi-reservoir plan and iii) trans-basin plan. On the other hand, in view of the project purposes, the alternatives are grouped into; i) irrigation only and ii) irrigation with hydro-power generation.

Consequently, 14 cases were selected with the combination of proposed reservoirs and its purposes. The disposition of the reservoirs, irrigation areas and the hydro-power station for the alternatives are illustrated in the Figure 4B-1 in Appendix 4B-1 with the combination of reservoirs and their purposes.

(b) Initial Studies for the Alternative Studies

The following studies were made in advance of the alternative studies.

i) Optimal Cropping Calendar

In order to use the natural rainfall as an effective rainfall for irrigation as much as possible, simulation analysis of the optimal cropping calendar was performed. By means of maximizing the rainfall use, it will be possible to minimize the artificial water supply through the irrigation canal and the required storage capacity. It will be better to make a balance between the peak demand during the land soaking period and the one during growing stage to use the irrigation canal section effectively. The land soaking period of 30-day, 45-day, 50-day and 60-day and at the same time the shifting of the respective cropping calendar every 10-day interval for nine types were studied to find the required peak demand, annual total diversion water requirements and effective

rainfall during the irrigation season. According to the results, the 50-day land soaking, starting from last 10-day of May, was selected to adapt as the cropping calendar for the project considering not only the available water resources point of view but also available labour force and farm mechanization.

ii) Dependable Trans-basin Discharge from Wahig Reservoir

It is necessary to anticipate the dependable discharge from the Wahig reservoir through the trans-basin tunnel. Initially, the required storage capacity for the Wahig upper area for 482 ha was estimated by the reservoir water operation study and 0.85 MCM was decided to be stored in the reservoir. Based upon the required storage capacity for the upper area, the optimal required regulating reservoir capacity was added to the said reservoir capacity. Several trial-and-error method was performed to find the effective regulation capacity of the reservoir. Consequently, 1.03 MCM was decided to have the regulating capacity for trans-basin on the basis of the 2-year return period of flood to be regulated in the reservoir. The required total storage, therefore, becomes 2.80 MCM, of which 1.88 MCM in the effective storage and the sedimentation volume of 0.92 MCM for 100-year. The full water surface elevation is EL 265.5 and the elevation of the inlet for the trans-basin tunnel was decided at EL 261.0 on the basis of the required storage capacity for the Wahig upper area.

iii) Required Storage Capacity of the Malinao Diversion Dam

Considering the submerged acreage of the existing communal irrigation area and the topographical conditions, the maximum full water surface elevation was limitted at EL 152.0. The reservoir water operation studies, together with the Pamacsalan reservoir and the Malinao diversion dam as a function of after-bay, was performed for the irrigation only and irrigation with hydro-power generation. Actually, the irrigation only case is possible to reduce the required storage

capacity of the Malinao diversion dam up to 2.5 MCM, while the Pamacsalan reservoir capacity should be increased. On the other hand the Pamacsalan capacity can be reduced when the Malinao diversion dam has the maximum storage capacity of 3.3 MCM. The required construction cost for the both cases becomes almost same. As for the irrigation with hydro-power generation, the Malinao capacity requires up to the maximum condition of 3.3 MCM to regulate the excess water of hydro-power generation, especially, during non-irrigation season. Accordingly, the Malinao diversion dam was decided to have a storage capacity of 3.3 MCM. The Malinao diversion dam was designed to have three units of gates for whole river course, out of which one gate has a function of scouring sluice. Therefore, the sediment storage was not considered in the total storage volume but the dead water below the elevation of intake bottom was considered as the sedimentation for 0.061 MCM. In order to regulate the water release discharge for the daily peak power generation, 0.065 MCM has been added to the total storage capacity, so that the total storage capacity amounts at 3.426 MCM.

iv) Features of Hydro-power Generation

In accordance with the disposition of the reservoirs among the alternatives, when an after-bay is available in the downstream of main dam, firm peak power generation for 24 to 6-hour was adopted considering the daily pattern of the power demand and increasing the minimum power generation capacity. On the contrary, without an after-bay case, the peak power generation will not be possible because the irrigation water requires for 24-hour supply, so that a firm power generation for 24-hour supply is taken into consideration. Estimation of kilowatt value as a benefit of power generation was performed on the basis of dependable capacity taking the average capacity value for 20-years on 10-day basis. Annual energy production value, KWH, was estimated on the basis of generated hours and capacity value for each year on 10-day basis.

v) Irrigation Acreage for the Upper Area

Regarding the proposed reservoir and location of upper area, some of the alternatives in the upper area can not be served the irrigation water from the reservoir. It is planned that the existing communal areas together with the existing grassland was combined to the Wahig upper area and Pamacsalan area by constructing a new diversion weir and main canal for the respective area. As for the Pamacsalan upper area the total abailable land is only 139 ha. It can be guaranteed to supply enough irrigation water even without a reservoir. However the available land for the Wahig area is 490 ha and it will be rather difficult to supply the enough irrigation water for that area without reservoir. The possible irrigation acreage was estimated in case of diversion weir only for the first and second crop separately. As the results, the first crop and the second crop can be irrigated for 256 ha and 400 ha respectively on the basis of 5-year return period of drought condition since the area could not be served by a reservoir. The reason why the irrigation acreage of the first crop is smaller than that of the second crop, are that the cropping calendar starting from the last 10-day of May, which is still dry season in some of year, has been adopted. As mentioned in the section of hydrology, during the wet season in August or September in some year, the rainfall amount falls in rather dry month as shown in Appendix 3B-2. These rainfall characteristics might affect the possible irrigation acreage for the first crop.

The upper areas of Pamacsalan and Wahig, therefore, were included to the service area of the Project Area as a benefitial area.

(c) Results of the Alternative Studies

Based upon the aforementioned anticipated results of analyses, the reservoir water operation on each case of the alternatives was performed by varying the irrigation acreage and/or firm power discharge to find the maximum attainable scale of development. The required reservoir capacity was decided on the basis of the second

maximum among the analyzed period of 20 years which corresponds to 10-year return period of drought and the carry over condition of reservoir within 3 years. The criteria of the operation rules were set forth to be adopted for the reservoir water operation as shown in Appendix 4B-1.

Since the water cost per unit reservoir capacity against the dam construction cost becomes the lower when the irrigation acreage become the bigger, the maximum attainable irrigation acreage and/or minimum discharge for power generation were selected as the optimal scale of development in each alternative.

According to the scale of reservoir capacity obtained, irrigation acreage and/or firm power discharge in each case, the construction cost including contingency but excluding the price escalation and the benefits were estimated. Based upon the cost-benefit analysis, the internal rate of return (hereinafter called IRR), construction cost per hectare, allocated cost for power generation and B/C ratio of hydro-power generation were analyzed for each alternative as shown in Table 4B-3, Appendix 4B-1.

The results show that the Case II-A-2, which is the case of irrigation only and the combination of Pamacsalan dam and Malinao diversion dam with storage function, indicates the highest IRR of 16.9 percent among the alternatives and the second one is the Case I-A-1 which is a single reservoir plan of Pamacsalan reservoir only in the case of irrigation only and the IRR is 16.1 percent. The case II-B-2 shows that the IRR is 15.9 percent, however, the IRR is the highest among the cases of irrigation with hydro-power generation and the construction cost per hectare becomes the lowest among the alternatives because of the cost allocation for hydro-power generation.

The B/C ratios of the hydro-power generation schemes indicate that the scheme could not be justified from the economical point of view due to the limitation of water resources and irrigation scheme as the main purpose of the project. However, the hydro-power generation

can greatly contribute to the rural electrification and social benefit, especially together with the irrigation development and modernization of agriculture. These intangible benefits were not justified in the economic analysis. The water utilization in this project for irrigation certainly affects to the downstream project such as the Wahig river downstream hydro-power generation scheme. It will be inevitable to include the hydro-power generation scheme in the project and it will be recommendable to include the scheme from the view point of compound utilization of limited water resources.

Consequently, the Case II-B-2, that is, combination of the Pamacsalan reservoir and Malinao diversion dam with storage was recommended as an optimal scale of development to be implemented for the project.

2. Proposed Scheme of Development

The main structures of the project are the Pamacsalan reservoir and Malinao diversion dam with storage function. The purposes of the project are irrigation and hydro-power generation.

The configuration of the project dimensions are shown as follows;

Pamacsalan Dam

Catchment Area:	28.0 sq.km
Total effective storage capacity:	30,180,000 cu.m
for irrigation:	28,380,000 cu.m
for power:	1,800,000 cu.m
Sedimentation capacity (100year):	1,120,000 cu.m
Total storage capacity:	31,300,000 cu.m
Full water surface area:	1,260,000 sq.m
Normal water surface elevation:	EL 248.5 m
Dead water elevation:	EL 207.5 m
Dam crest elevation:	EL 251.5 m
Height of dam from the foundation:	67.5 m

Malinao Diversion Dam

Catchment Area:	138.8 sq.km
Total effective storage capacity:	3,365,000 cu.m
out of which for irrigation:	3,300,000 cu.m
for power for daily peak regulation 1/ :	65,000 cu.m
Sediment capacity 2/:	61,000 cu.m
Total storage capacity:	3,426,000 cu.m
Full water surface area:	1,098,000 sq.m
Normal water surface elevation:	EL 152.0 m
Dead water elevation 3/:	EL 143.0 m
Dam crest elevation:	EL 154.5 m
Height of Dam from the foundation:	24.5 m

Note: 1/ The storage volume is added for the purpose of regulating the daily peak power generation for at least 6-hour.

2/ As the diversion dam is gated type for the whole width of river course, the sedimentation can be flushed out to the downstream. The sediment capacity is estimated the dead water capacity below the bottom of intake.

3/ Dead water elevation is set at the bottom of intake elevation.

Irrigation Area

Lower Area:	4,800 hectares
Pamacsalan upper area:	120 hectares
Wahig communal rehabilitation area for 1st crop (May to October):	256 hectares
for 2nd crop (November to March):	400 hectares
Total Irrigation Acreage:	5,320 hectares

Hydro-power Generation

Installed capacity:	1,700 KW
Installed unit:	850KW x 2units
Firm peak power capacity:	850 KW
Dependable capacity:	1,225 KW
Annual energy production:	5,175 MWH

Plant factor: 36.2%

Transmission line to Carmen: 69 KV

3. Reservoir Plan

The water balance of the results of reservoir water operation study for the selected plan is shown in the Appendix 4B-3.

The 20-year average of annual water demand for the irrigation is 54.7 MCM/year which corresponds to the 1,110.9 mm/year and the exclusive use of water for hydro-power generation is 9.6 MCM/year, so that the total demand amounts 64.3 MCM/year. As for the water supply side, the amount of 38.1 MCM/year, which is 59.3 percent of the total demand, will be supplied by the Malinao diversion dam and 25.8 MCM/year, which is 40.1 percent of that, will be supplied by the Pamacsalan reservoir. Water shortage is occurred in 1968-69 only during the 20-year period for 7.8 MCM which correspond to the 0.6 percent of the total demand in average. In average, the water supply from the Malinao diversion dam exceeds the one from the Pamacsalan. As for the drought year in 1965-66 and in 1972-73, the respective total demands are 88.2 MCM and 77.6 MCM while the water supplies from the Malinao diverison dam are 39.2 MCM (44.5 percent of total demand) and 36.2 MCM (46.7 percent of that), and these from the Pamacsalan dam are 48.9 MCM (55.5 percent of that) and 41.3 MCM (53.3 percent of that). In the drought year, the water supply from the Pamacsalan reservoir exceeds the one from the Malinao diversion dam.

The utilization of natural river flow for the project indicates that in average the 63.8 percent of the river flow will be utilized for irrigation and hydro-power generation purposes at the Pamacsalan reservoir. At the Malinao diversion dam site, the 57.7 percent of the total river water will be utilized for irrigation water.

As for the repeated use of the stored water, 10.2 MCM/year in average will be released from the stored water, that corresponds

3.1 times/year of the storage capacity of 3.3 MCM at the Malinao diversion dam. In the maximum conditions, 5.3 times/year of the storage capacity in 1967-68 has been released from the stored water. On the other hand at the Pamacsalan reservoir, in average only 0.4 time/year of the storage capacity of 30.18 MCM will be released from the stored water. In the drought year, 1.2 times/year and 1.0 times/year of the storage capacity will be released from the stored water in the Pamacsalan reservoir in 1965-66 and in 1972-73, respectively. The efficiency of the storage capacity against the total river flow becomes 74.6 percent.

As mentioned above, the river flow utilizayion at the Malinao diversion dam on average is 57.7 percent of the total river flow, in other words, 42.3 percent of the river flow, that is 46.8 MCM, will not be utilized for the project and over-flowed to the downstream. Even the droughtest year in 1968-69, 17.8 MCM of the water over-flowed to the downstream without utilization for the project. There might be still potentiality to develop another project in the downstream. However, the seasonal pattern of the over-flow is very much fluctuated due to the reservoir capacity. Therefore it will require careful studies to utilize the water effectively.

4. Irrigation Plan

(a) Irrigation Water Requirement

Potential Evapotranspiration

Potential evapotranspiration (ETp), generally recognized as fairly reliable index in calculating consumptive use, can be determined by number of methods, such as the evaporation measurement from evaporation pans and the application of empirical formula based on the climatological data. In the Project, the evapotranspiration of the proposed crop is estimated by applying the Penman Method[1/], based on the climatological data observed in Tagbilaran.

1/ Penman Method: This is the most complete theoretical method for the rather humid area not far from ocean and essentially covered with growing vegetation.

Consumptive Use

The consumptive use (actual evapotranspiration, ETa), which is assumed to be equal to evaporation, is estimated by multiplying the estimated ETp values by crop coefficients which express the relationship between potential and actual evapotranspiration during distinct vegetative stages of the crops.

No data on such coefficients, however, are available in the vicinity of the Project Area, so that the ETa for the Project Area is adjusted by the ratio of an actual evaporation observed at Dumaguete City and the potential evaporation estimated by the Penman Method.

The following table gives the consumptive use of crops estimated by the above procedure on the monthly basis.

Estimated Consumptive Use

Month	ETp[1] (mm/mon)	Adjusting Ratio[2]	Adjusted ETp (mm/mon)	Adjusted ETp (mm/day)
Jan.	110.9	1.47	163.0	5.3
Feb.	102.7	1.37	140.7	5.0
Mar.	132.0	1.38	182.2	5.9
Apr.	141.7	1.46	206.9	6.9
May	136.7	1.50	205.0	6.6
Jun.	114.0	1.50	171.0	5.7
Jul.	113.6	1.49	169.2	5.5
Aug.	122.1	1.42	173.4	5.6
Sep.	113.7	1.27	144.4	4.8
Oct.	115.4	1.28	147.7	4.8
Nov.	103.6	1.41	146.1	4.9
Dec.	101.0	1.34	135.3	4.4
Average	117.3	1.41	165.4	5.9

1/ Estimated ETp based on the data observed at Tagbilaran.

2/ See Table 3B-16 in Appendix 3B-3

Crop Water Requirement

Crop water requirement on the 10-day basis is estimated based on the proposed cropping pattern. In this estimate, the following assumptions are made:

- percolation rate in fields is one millimeter per day throughout the growing period of paddy.
  Percolation rate was measured at several places in the existing paddy fields, and it was found that all of the paddy fields had impervious nature with low percolation rate of less than one millimeter. Detailed observation data are shown in Table 4B-5 in Appendix 4B-4.

- additional water supply for land soaking and preparation is decided at 210 mm for the wet season paddy varieties and 170 mm for the dry season paddy varieties as shown below:

Water Requirement for Land Preparation

Item	Wet Season Paddy (mm)	Dry Season Paddy (mm)
1st irrigation for land soaking	150	120
2nd and 3rd irrigation	60	50

Note: See Table 4B-6 in Appendix 4B-4.

The estimated crop water requirement is shown in Figure 4B-9 in Appendix 4B-4. The maximum average crop water requirement of paddy during 10-day is estimated at 10.9 mm/day in the middle 10-days in July for the wet season paddy.

Diversion Water Requirement

Diversion water requirement should be calculated by taking into account the effective rainfalls and water losses in adding to the average crop water requirement weighed by the planted area. The criteria of the effective rainfalls and water losses used for the Project are as follows:

- Effective Rainfall

The effective rainfall during land soaking period is estimated

at 210 mm considering the land soaking capacity. The maximum effective rainfall during the growing stage is estimated at 60 mm considering the minimum flooding depth of 20 mm in the paddy field. Therefore, the maximum allowable flooding depth in the paddy field is 80 mm.

- Irrigation Efficiency

In the estimation of diversion water requirement, the following are adopted; i) farm efficiency of 70 percent and 73 percent for wet and dry seasons respectively, ii) conveyance efficiency in the canal of 85 percent for both seasons and iii) operation efficiency of 90 percent for both seasons. (See Table 4B-7 in Appendix 4B-4)

(b) Design Discharge of Canals

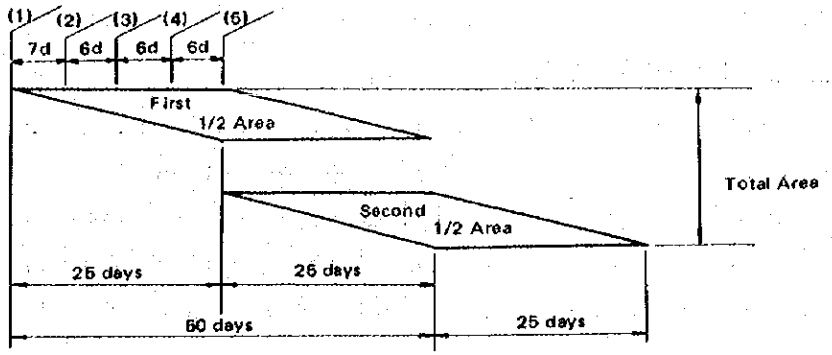
Land Soaking and Land Preparation

According to the natural environments and cultivational habit of farmers, the process of land soaking and land preparation is designed to comprise one plowing followed by three times of harrowing with an interval of six days for each time for land plot.

The first irrigation is proposed at seven days before plowing for land soaking, then second irrigation will be given at 13 days later to prevent the field from drying. The last irrigation will be applied just before the last harrowing which may be followed by transplanting immediately.

Generally, the period to complete the land preparation for the whole Project Area is decided at 50 days. However, the area in one irrigation rotational area covering the area of about 25 ha can be finished within 25 days. Therefore, within these 25 days, transplanting schedule will be one half of the said area in each 25 days period. Irrigation and preparation schedule so arranged can be illustrated in the following figure. Depth of water applied by each time of irrigation is also estimated in Figure 4B-9 in Appendix 4B-4.

Illustration of Working Schedule for Land Soaking and Preparation



(1) : First Irrigation for land soaking
(2) : Land Plowing
(3) : First harrowing and second irrigation
(4) : Second harrowing
(5) : Third harrowing and third irrigation

- Design Discharge of Terminal Canals

The design discharge of terminal canals such as main farm ditch and supplemental farm ditch of which description will be given in subsequent paragraph, will be decided by the following procedure; land soaking and land preparation in one rotational irrigation area covering area of 25 ha on average is planned to be carried out within 25 days with five days rotation, then design discharge of the canals are determined based on the following assumptions:

Water requirement for land soaking and land preparation:	
wet season paddy:	210 mm
dry season paddy:	170 mm
Land preparation period:	25 days
Rotational irrigation:	5 days
Application losses:	
wet season paddy:	30 %
dry season paddy:	27 %

Consequently, the design discharge of the terminal canals are calculated at 34.8[1/] lit/sec, which is equivalent to 1.39 lit/sec/ha inclusive of 30 percent of application losses.

- Design Discharge of Main and Lateral Canals

According to the proposed cultivation schedule in which separate application of land soaking and preparation water will be carried out within 50 days, the maximum weighted water requirement appears in mid-June with the amount of 1.414 lit/sec/ha, and as a result, the maximum design discharge at the proposed Malinao diversion dam site is estimated to be 6.79 cu.m/sec. Figure 4B-9 in Appendix 4B-4 indicates the weighted water requirements based on the proposed cultivation scheme mentioned above.

5. Drainage Plan

(a) Drainage Modulus for Designing Drainage Canals

Drainage in Irrigated Area

In general, excess water in paddy fields shows the following phenomena:

- The excess water during and after heavy rains overflows from the paddy field to the neighboring lower paddy field.

- In sloping area, the overflow mentioned above is hydraulically the same phenomenon as seen at a broad-crested weir of free overflow type. In this case, a quantity of overflow discharge is decided by the difference of the water levels in the upper and lower paddy fields. On the other hand, in an area having not much difference of the water levels in two adjoining paddy fields, the quantity of overflow discharge is decided mainly by the water level in the lower paddy field as seen at a submerged broad crested weir.

1/: 210mm x 10^{-3} x 25ha x 10^{4} x 10^{3}/25days x 86,400 x 0.7 = 34.8ℓ/sec

- Both in sloping and slightly sloping areas, the paddy field from which excess water is naturally discharged to the lower paddy fields has no drainage problem, and even if a paddy field is submerged by excess water, paddy does not suffer from it in case the water depth and duration are within the allowable extent.

- However, the paddy field located at the lowest end has not placed to discharge excess water, if no measures are taken. It is generally said that the natural drainage by gravity, is effective in the areas having a slope of more than 15 cm/km. In the other areas especially flat or very slightly sloping area, the drainage problem is caused, and some facilities including pump are required.

Method for Estimation of Drainage Modulus

Studies have been made to clarify the relationship between the possible deduction of paddy rice yield and excess water discharge. In general, water of more than 10 cm depth causes a damage in yield of paddy rice according to the inundation period and an average depth in this duration. Therefore, an actual maximum depth in the lower paddy fields does not play an important role in this study. The study has been made based on the following simplified principles and assumptions.

- The excess water in higher paddy fields is discharged immediately to lower paddy fields.

- All rainfall in the block in the Project Area flows into depressed areas such as lower paddy fields, which occupied (1/A) of the total area of block.

- The irrigation water supply is stopped during the heavy rainfall period.

- The depth of standing water after n days from the starting date of rain is as follows:

$$D = A[R(n, max)_T - n\ (DC + CU)]$$

Where: D: depth of standing water after n days in mm

$R(n, max)_T$: maximum rainfall during n days in mm, which is equal or exceeds the rainfall of once every T years.

DC: drainage capacity in mm/day

CU: consumptive use of paddy rice in mm/day:
CU = 6.0 mm/day

- It is assumed from topographic map that the depression area occupies about 20 percent of the total area of block. This means that the value of A is 5.0.

- If a smaller percentage than 20 percent is chosen, the damage itself becomes severe because the concentration of a certain water quantity in a smaller area causes a deeper standing water during longer time. On the contrary, if a larger percentage is chosen, the damage will not be so severe in comparison with the above case because both the depth and duration of standing water become small. In the former, the damage is severe but damaged area is limited, while in the latter the damage is not so severe but large area suffers from standing water. Under the situations, a total yield reduction will not be much affected by the difference of A value.

- The other factor to estimate the depth of standing water in lower paddy fields is the design return period of (T). If a small return period such as two or five years is adopted from the economic point of view only, the Project Area will be frequently suffered from the standing water. On the contrary, if a larger return period is chosen for drainage, it will result in increase of costs. The decision of the return period should be made only after having compared the benefits with costs in a number of alternatives. For the moment, the value of T is decided at five years in this study from the aspect of agricultural development.

- It is considered that the combination of A = 5.0 and damage amounting to 20 percent of the yearly yield of paddy will lead to a reasonable relation between the value of increased yield of paddy rice and the cost for drainage facilities.

- In general, even if a paddy field is submerged by excess water of more than 10 cm depth, paddy grown in the field does not suffer from it in case that its duration is less than three days and an average standing water depth in the duration is less than 25 cm.

In applying the above-mentioned calculation method, it appears that one or two days rainfall has to be drained so that the depth of excess water in paddy fields is less than 250 mm.

$$D_1 = A\,[R\,(1, \max)_T - DC - CU]$$

$$D_2 = A\,[R\,(2, \max)_T - 2DC - 2CU]$$

$$\frac{D_1 + D_2}{2} = 1/2\,A[R(1, \max)_T + R\,(2, \max)_T - 3DC - 3CU] < 250$$

and the following formula is derived from the above equations,

$$DC > 1/3\,R(1, \max)_T + 1/3\,R\,(2, \max)_T - 500/3A - CU$$

Estimation of Drainage Modulus

On the basis of the above-mentioned assumptions and principles, the drainage modulus of 6.60 lit/sec/ha is computed, which is equivalent to the drainage capacity of 57.0 mm/24hr. In this estimate, the following average probable rainfalls observed at the stations of Dagohoy are used.

Maximum Probable Rainfall

(unit: mm)

Return Period	R (1, max)	R (2, max)
5-year	120	168
10-year	135	185

The modulus of 6.60 lit/sec/ha could be applied to the area smaller than 400 ha, but a smaller modulus should be applied to a larger area than the above-mentioned because the rainfall intensity becomes low in a large area than 400 ha. Figure 4B-10 in Appendix 4B-5, shows an approximate linear double logarithmic relation between a reduction factor and an area.

When such reduction factor (Γ) is applied to the areas larger than 400 ha, the discharge criteria are obtained. The discharge criteria for drainage are tabulated below:

Discharge Criteria for Drainage

Area (ha)	Drainage Modulus (lit/sec/ha)
0 - 400	6.60
400 - 1,000	6.40
1,000 - 3,000	6.14
3,000 - 5,000	6.01
5,000 - 10,000	5.87

6. Road Plan

The proposed roads in the Project are classified as follows;

Provincial Roads

The existing two provincial roads within the Project Area, the roads connecting between Barrio Katipunan and Mahayag and between Barrio Estaka and Caluasan, will be improved in coordination with the provincial government of Bohol and the Department of Public Highway so that these roads will function as the truck roads in the Project. The proposed roads will have the width of six meters paved by base coarse materials.

Service and Access Roads

The service roads are to be provided along the main, lateral and sub-lateral canals in order to execute operation and maintenance of the constructed irrigation and drainage facilities as well as to transport the inputs, outputs and productions, and the access roads to be provided aims at connecting among the provincial roads, service roads

and barrio roads each other. The proposed roads have two types of width, six meters and 3.5 meters, and will be paved by base coarse materials.

Barrio Roads

The barrio roads having the width of 3.5 meters are planned to be constructed for the communication between the Barrio level. Base coarse materials will be used for the pavement of them.

On-farm Road

On-farm roads, which are the terminal roads in the Project Area for farming are planned to be located along the main farm ditch, and these will not be paved. The width of the roads is two meters.

7. Farm Land Development Plan (On-Farm Level)

The farm land development consisting of land terracing and levelling and the provision of terminal on-farm facilities such as farm ditch, farm drain and farm road are essential works to execute the irrigated agriculture including farm mechanization, and in these works, farmers' eagerness for agriculture will act as the prime mover. With their support, the rationalized land parcelling and land allocation will be materialized, which are the pre-requisite for upgrading the agriculture. Thus, modernized irrigation and drainage systems as well as new organization for farm management will be established at an early stage.

(a) Premise in Farm Land Development

Farm Managements

An average cultivation area per farm household to be allocated in the Project Area is 2.5 ha. For common use of farm road and irrigation and drainage canals and especially for rotational irrigation based on an rationalized irrigation schedule, Irrigators' groups will be organized by farm households in a cultivation area of about 50 ha involving the two rotational area of about 25 ha.

Crops

Paddy of high yield varieties as the major crop will be grown in both the wet and dry seasons after the implementation of the Project. This project will increase cropping rate up to 194 percent and the yield of paddy rice per unit area also increase up to 235 percent of the existing one.

Farm practices

For the farm practices to grow paddy, an integrated farm mechanization system will be established using tractor, thresher and dryer which will be introduced for land preparation, threshing and drying works respectively, and the other works will mostly be made by a combination of manpower and carabao for the time being.

(b) Land Parcelling

1) Principles for Land Parcelling

In order to materialize the farm land parcelling satisfying all the requirements mentioned above in the Project Area in which remarkable rolling topography is prevailing with an average slope of two to three percent, due attentions should be paid to the following;

i) to plan it in close relation with the farm management plan;

ii) to plan it for materializing rationalized irrigation and drainage water control, and,

iii) to plan it for rationalized farm management for paddy cultivation.

Further details on the above mentioned facts are as follows:

i) to determine the location of main service and access roads as the bones of land parcelling on the basis of the proposed formation of Irrigators' Association, unit farm management group serving the area of about 200 ha to 300 ha, as well as

rural community development and public facilities construction plan.

ii) to determine the location of irrigation and drainage canals taking into consideration the topographic conditions, the separation of irrigation and drainage canals, lengths of terminal canals and rotational irrigation. In order to systematize and simplify the water supplying systems at terminal on-farm level, a commanding area of one turn-out is planned to correspond to one rotation area of 25 ha on average.

iii) to provide all the farm plots with the maximum length of terrace of about 100 m and width of terrace of about 30 m, of which dimensions will vary based upon the slope of land. However, the size of plot is planned to be the same as much as possible to simplify the extension of new technique for paddy cultivation to farmers. If all the farm plots are in almost the same size, a certain quantity of agricultural chemicals can be sprayed to each farm plot to control the disease and insect damage. The same can be said in fertilizer application. Furthermore, planning and execution of both the puddling works by tractors and management of irrigation water supply for puddling will be simple and easy for the reasons as aforementioned.

2) Size of Plot and Land Parcelling Plan

Generally the size of the plots should be determined in close relation with topographic conditions, technical systems to be introduced for crop cultivation, crops to be grown, farm machinery to be operated as well as the scale of cultivated area per farm household. To determine suitable size of plot and land parcelling plan, two methods of water supply systems are planned, namely:

Case A: main farm ditch is aligned across the contour lines, so that supplementary farm ditches will be located along the contour line.

Case B: main farm ditch is arranged along the contour line, thus locating the supplementary farm ditches across the contour lines.

Case A is more economical than Case B because Case B requires many drops on farm ditches due to topographic conditions. In the plan of Case A, proposed supplementary farm ditches and drainage canals will be utilized at the same time. These two plans are to be applied fittingly to the site based upon the topographic conditions in the Project Area. The size of farm plot in any case is planned to be about 0.3 ha in maximum, length of terrace of 100 m and width of terrace of 30 m in maximum, and the length of terrace will be located along the contour line. Typical layout of the land parcelling and design criteria for terracing is indicated in Appendix 4D-5. The criteria are developed in order to reclaim the hilly area by the Bureau of Soils for terracing along the contour lines.

(c) Terminal Water Management System

Irrigation System

Turn-out will be constructed on the lateral irrigation canals so that the main farm ditches will stretch out from each turn-out. A total length of main farm ditches, which will be located along farm roads, will range from about 500 m to 1,000 m, and these main farm ditches will command an area of about 25 ha (one rotation area). In order to divert irrigation water from the main farm ditch to farm plots, supplementary farm ditches will be provided for the area of about 5 ha, one rotational unit.

Irrigation water supply during land soaking and land preparation is planned to be carried out within 25 days with five days rotation (one rotational unit per day in rotation block). In this case, the design discharge of the terminal canals, main farm ditch and supplementary farm ditch is 1.39 lit/sec/ha. Outline of the terminal irrigation facilities is described below:

Turn-out: the facility to divert irrigation water from a lateral irrigation canal to main farm ditch equipped with measuring devices and water control facilities. The control facilities are double gate type with constant head.

Main farm ditch: the irrigation canals made of earth to convey irrigation water to supplementary farm ditch. The design discharge is 1.39 lit/sec/ha.

Division box: the facility to divert irrigation water from a main farm ditch to supplementary farm ditch equipped with check structures made of wood.

Supplementary farm ditch: the terminal irrigation canals made of earth to convey irrigation water to farm plots. The design discharge is 1.39 lit/sec/ha.

End check: the facility to prevent overflow of irrigation water in the supplementary farm ditch to the farm drain.

Farm ditch check and drop: the facility to limit the flow of water within the non-scouring velocity in steep slope of farm ditch.

Farm road: the terminal road prepared for farmers to go in and out from farm plots, and main farm ditch is located along its one side.

Culvert (1): the facility installed across a farm road adjacent to the turn-out so that water in the main farm ditch can flow through it without being intercepted by the farm road. A pipe with diameter of 12" and the length of 6.0 m will be used for this purpose.

Culvert (2): (Farm ditch crossing) — the facility installed under a farm inlet so that water in a main farm ditch can flow through it without being intercepted by the farm inlet. A pipe with diameter of 12" and the length of 3.0 m will be used for this purpose.

Drainage System

Excess water in each farm plot is drained through a notch with a width of about 30 cm to a supplemental farm ditch which has a role of terminal drainage canal or farm drain. Supplemental farm ditches and farm drains made of earth are linked to a drainage canal at their lowest reaches. The design discharge of the farm drains is 6.60 lit/sec/ha.

Outline of the terminal drainage facilities are as shown below:

Farm drain: — the terminal drainage canal made of earth to be constructed in each rotational unit. Its design capacity is 6.60 lit/sec/ha.

Culvert (3): (Drainage inlet) — the facility to be installed across a farm road at the lower reaches of farm drain so that drainage water can flow across the road without being intercepted by the road.

8. Electric Hydro-power Development Plan

(a) General

Although gradual progress of electrification is being made in the Province of Bohol, the water resources development of power remains in a primitive stage. As stated in the previous chapter, there exists only one hydro-power station at Loboc with a capacity of 1.2 MW, all others are diesel power plants.

Under these circumstances, the Pamacsalan dam, of which a major function is the storing of irrigation water for the Project Area, is

planned for generation of electric power from stream water energy together with water supply.

(b) Optimal Scale of the Installed Capacity

The required transmission line is estimated on the basis of the NPC transmission line scheme which could be expected to install a sub-station at Carmen with 6.9 KV transmission line. Regarding the installed capacity of proposed plants, the following three alternatives were studied to select an optimal scale. And after careful study, Plan-2 has been finally selected for incorporation at the Pamacsalan dam site in accordance with cost and benefit analysis.

Plan-1: 24-hour generation is carried out through the year for firm power, and the power plant has limited generation size for demand in the Project Area only.

Plan-2: Yearly generation for firm peak power is possible. But generation hours per day are limited to 6-24 hours according to the irrigation schedule.

Plan-3: Only peak power is taken into consideration. Peak generation is carried on as much as performance allows.

As for Plan-2, firm peak power generation, which can be guaranteed throughout a year, is quite high as compared with the demand in the Project Area. Also hydro-power can be generated in the high performance of the power plant even in a drought year due to the function of the after-bay at Marinao diversion dam and two turbine units. The maximum discharge for power generation was estimated by the water release from the dam for irrigation water supply as shown in Figure 4B-11 in Appendix 4B-6. The optimal scale of maximum discharge was decided at 3.0 cu.m/sec in accordance with the optimization of the installed capacity.

Plan-1, the unit cost of power generation is quite high and also the B/C ratio is low. In addition, maximum capacity is 600 KW and firm capacity is 230 KW. These small capacities of power generation can not satisfy power demand in the Project Area. As for the third plan, the unit cost of power generation as well as the B/C ratio are higher than the second plan. However the installed unit is only one, so performance during low head and low discharge will be low. It might have cavitation effect and the life time of the turbine would be decreased.

Accordingly, it has been decided to use Plan-2 for the project. (See Table 4B-11 in Appendix 4B-6) The mode of power generation of the second plan is deemed best for its main purpose of firm peak power. The power plant is equiped with two sets of generator so as to be operated at partial load during the non-irrigation season and even during the irrigation season when the irrigation water supply become less due to an effective rainfall. The plant is planned to generate at least six hours a day by according to a 24 hour discharge of 0.4 cu.m/sec to 1.6 cu.m/sec.

C. Proposed Agricultural Development

1. Proposed Land Use

Out of 7,300 ha of gross area, 73 percent or 5,320 ha is planned to be irrigated. Three percent or 194 ha will be used as upland fields. About 24 percent or 1,786 ha comprises project facilities area, village and public area and others (see Table 4-1).

The proposed canals will be able to irrigate 5,320 ha by gravity, out of which about 3,870 ha shall be newly developed from grasslands (cogon areas) and upland fields to the paddy fields where there may be no problems in topographical and soil conditions. 194 ha of upland field whose elevation is relatively low will be cultivated with coconut and banana, etc. as present land use. Out of 1786 ha, some area will be able to be utilized for growing corn and pasture lands for their home consumption and carabao breeding.

Entire area of 5,320 ha will be utilized for paddy cultivation with irrigation after the Project. Paddy is most suitable crop to the natural conditions such as soil and climate in the Project area. And also farmers desire to grow paddy very strongly. As for diversified crops, it may be difficult to introduce them in large-scaled area in view of their poor marketability, unfavorable soil conditions to grow must of crops and small possibility of field irrigation for them.

Out of 5,320 ha, 3,318 ha is belong to the land class of 2R and 2,002 ha to 3R according to the result of land classification for paddy cultivation.

2. Proposed Cropping Pattern

Necessary volume of irrigation water will be provided in order to realize the double cropping of paddy per year in the area of 5,176 ha out of 5,320 ha. The remaining 144 ha will be supplied irrigation water for only dry season crop.

Table 4-1. Proposed Land Use

(unit: ha)

Land Category	Upper Area			Lower Area	Total
	Wahig	Pamacsalan	Sub-total		
Paddy Field 1/	400	120	520	4,800	5,320
Coconut etc.	17	-	17	177	194
Others 2/	106	57	163	1,623	1,786
Total	523	177	700	6,600	7,300

Remarks: 1/ Entire area will be served with irrigation by the Project.

2/ Consists of the areas for Project facilities, villages and public areas and others.

The 125-day cropping period and 50-day lag period will be given respectively to the paddy growth of recommended varieties and farm operations as is seen in the proposed cropping calendar for both wet and dry season crop (see Figure 4-1). For the wet season cropping, the land preparation will be started in late May to July while for the dry season cropping it will be started in late October. The harvest time will be September to October and around March for the wet and dry season crops respectively.

The recommendable rice varieties in the area are IR36, 32, 38, 40 and 42 at present. Especially IR 36, 32 and 38 are the most recommendable ones because they have genetic registance to severe virus diseases and biotype 2 of brown planthopper.

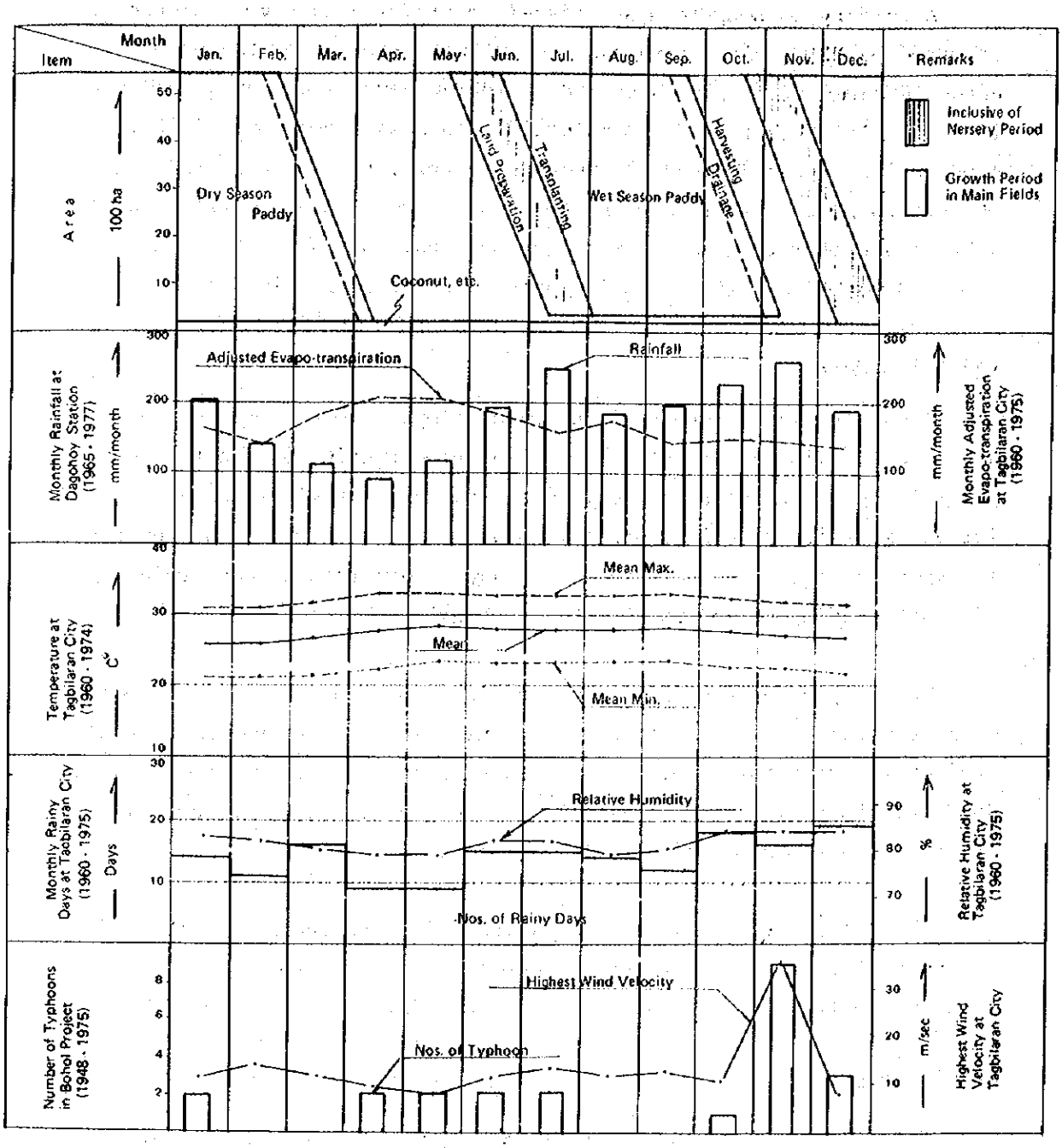
For better maintenance of irrigation facilities, a sufficient period should be provided in this cropping calendar. Namely, 50 days of non-irrigation period in April and May, between wet and dry cropping is planned. This will also contribute to effective utilization of the limited water resources. The 50-days of lag period for each cropping will allow the peak labor requirement to be optimized and get the cost of on-farm irrigation canals to be cheap.

The possibility of introducing 5 cropping for two years and triple cropping for one year were studied. But presently the double cropping per year might be most suitable in the project area because of the limited amount of irrigation water and also insufficiency of labor supply in the condition of relatively big farm size.

The proposed cropping pattern will give the highest productivity and convenience in farming activities, relating to weather conditions in the Project Area.

The cropping intensity in the whole arable area is computed at 194 percent.

FIGURE 4-1. PROPOSED CROPPING PATTERN



3. Market Prospect

According to Long-Term and Five-Year (1978-1982) Development Plans prepared by NEDA, rice, corn and coconut will keep to be the major crops in terms of land area by 1987. In the next five years, self sufficiency will be attained and maintained in basic food commodities. Food grains production will be raised in future, thus causing the present deficit to progressively decline from about 100 thousand metric tons in 1978 to about 38 thousand metric tons in 1980. By 1981, a surplus of about 10 thousand metric tons is anticipated to be realized.

(a) Rice Market

According to the grains industry development plan prepared by the NGA, Central Visayas is only the region where continuous shortage of paddy is up to the year of 2000. However, Bohol Province is only the island-exporting rice in Central Visayas. A great part of surplus rice is exported to Cebu. These surplus paddy is exported as commercial rice after being milled to save transportation cost.

The selling volume in rice market is assumed at about 45 percent of provincial gross production at present. The selling volume without project in the future would drop because of the increase of population. However, the selling volume with Project would hold a percentage like at present after completion of the Project.

The selling volume in five municipalities concerned is estimated at about 70 percent of the total production. Therefore, a rice production in the Project Area will play an important role in the market.

(b) Corn Market

The feature of cereal market in Bohol Province will be specialized to be export of rice and import of corngrits. Corn is a staple food but plays a subordinate role to rice in a provincial consumption. Consumed volume of rice and corn per capita per year are 100 kg and 30 kg, according to NGA in Tagbilaran. The difference on retail price of rice and corngrits and wholesale price of rice in Bohol and Cebu may issue

above trade pattern.

Balance of supply and demand of corngrits at present shows a shortage of about 60 percent to total requirement. To supplement this shortage about 255,000 bags are imported to Bohol, of which 155,000 bags are imported from Cebu.

The incremental rice to be produced in the Project Area would not only contribute to increase of exporting rice but also contribute to decline importing of corngrits.

(c) Consume Center for Incremental Rice

Cebu province, which has a close trade relation with the Bohol province for rice and corn markets, is the largest cereal market in Visayas islands.

Annual report prepared by NGA in Region VII, 1976 reports as follows:

Trade of Cebu Province

(unit: bags of 50 kg)

Cereal	Imported	Exported
Rice	694,000	442,000
Corn grains	6,658,000	20,000
Corn grits	309,000	1,748,000
Wheat grains	2,014,000	-
Paddy	35,000	-

The population of 3,371 thousand of Central Visayas in 1975 will be forecasted to 5,740 thousand in the year of 2000. The population in Cebu province, also, will be forecasted from 1,800 thousand to 3,000 thousand in same growth rate.

Therefore, Cebu would be considered as the consumers' centre for incremental rice produced in the Project Area.

(d) Fertilizer Market

At present, 70 percent of fertilizers consumed in the Province is supplied by Plantas Company Products and the remaining 30 percent by Atlas Co. Thus the distribution center of fertilizer for Bohol province may be in Cebu City where Eastern Visayas District Warehouse of Plantas Co. is located.

The country's fertilizer import reaches about 50 percent of consumption. Based on the FPA's supply/demand projections, the following importation would be made in 1977 and 1978.

Supply and Demand Fertilizer

(unit: 1,000 ton)

Description	1977	1978
Total demand (A)	731	747
Three months buffer stock (B)	-	187
Importable volume (C)	449	385
C ÷ (A + B)	61%	41%

The Government of the Philippines has a plan to import Urea from ASEAN Urea Plants of Malaysia and Indonesia after 1981. Importable volume may be projected from 322,000 ton in 1981 to 339,000 ton in 1985. In future, cheap ASEAN's Urea will be supplied to the Philippines in place of the costly European's one. This advantage has to be used in the estimation of shadow price of Urea in economic justification.

4. Agricultural Production

The target yields of paddy for wet and dry cropping are averagely 3.8 tons and 4.2 tons per hectare respectively. (see Appendix 4C-1).

The target yield is expected to be attained in around 5 years after the completion of construction works taking into account that most farmers are experienced in cultivating paddy in the Project area.

Sufficient supporting services should be provided to farmers throughout the project area and also proper on-farm facilities namely irrigation and drainage canals and farm road network, will be developed to meet the high production.

The estimated production will be about 42,200 tons of paddy per year or eight times higher than the present, 5,214 tons. The production increment of paddy rice is estimated to be approximately 37,000 tons every year. (see Table 4C-1, in Appendix 4C-1)

There are no major obstacle or problem to attain the projected high yield of paddy because typhoon seldom visits the area and no place is inundated and soil has the capacity to produce high yield.

The rationalized paddy cultivation as shown in Appendix 4C-2, with proper varieties and necessary amount of input materials shall be introduced to secure the target yield throughout the Project area. Furthermore, it should be planned to provide adequate extension service timely and systematically, for this purpose.

5. Forecasting of Population and Labor

The population in the Project Area as of 1975 was 21,300, and it has increased with an annual growth rate of about 2.9 percent in the last five years. The annual growth rate of population in five municipalities concerned was 3 percent in the same year which is very high in comparison with 2.1 percent in Bohol Province. As a result, the increase of population is noticeable in the Project Area, and this tendency might also continue in future. Forecasting of population in future is shown below.

Forecasting of Population

(unit: 1,000 persons)

Area	1970 1/	1975 1/	1990
Project Area	18	21	30 - 32
5 Municipalities	55	63	90 - 96
Bohol Province	683	759	1,006 - 1,037

Source: 1/ NEDA, 1977

In spite of the increase of total population, the population of workers of 10 years old or over having major gainful occupation in Bohol Province have decreased from 255 thousand in 1970 to 233 thousand in 1975. However, the number of farmers, fishermen, hunters, loggers and related workers have increased from 57.9 percent to 64.8 percent. These facts show the difference of absorption capacity of population between agriculture and other industries. And it may be presumed that the status of unemployment and under employment tends to increase. At present, many ambulant farm laborers come to the Project Area and its vicinities from Ubay, Carmen, Batuan, Jagna and Candijay, etc. during the labor peak season of palay harvest. These unemployment labor are amounted to about 3,000 persons and be considered as important supply source of hired labor to be needed in the Project Area in the future. (see Appendix 4C-3)

6. Farm Mechanization and Farm Labor Balance

Farm Mechanization will be needed for the proposed cropping schedule with improved water management through maximization of water utilization and high cropping intensity after the farm size will be expanded.

It is assumed that farm mechanization increase by 40 percent for land preparation of both wet and dry seasons, 100 percent for threshing by either power thresher or pedal thresher and 50 percent for drying. The farm machineries such as hand tractors, threshers and driers are locally available in the Philippines and a good number of

them are being used by farmers.

On the assumption that minimum numbers of these machinery will be collectively utilized among its compact farms (50 ha), the necessary numbers of machinery unit per one compact farm are as shown below.

Hand tractor (7-8 HP): two units
Power thresher (7-8 HP, throw-in type): one units
Pedal thresher: four units
Drier (flat bed type, 0.5 ton bin): one unit

The system of farm operation as shown in Figure 4C-3 in Appendix 4C-4 will be applied. The land preparation is carried out by a combination of hand tractor for plowing and carabao for harrowing.

Labor requirement of the farm operation system is estimated at 101 man-days per ha. Labor balance between the requirement and available labor force in the Project area shows some labor shortage of family labor at the peak requirement, which happen during transplanting season. (see Appendix 4C-5) But this shortage will be easily covered up by hiring the deficient labor inside and outside the Project area.

7. Input Material Supply

Total requirement of input materials such as seeds, fertilizers, insecticides and herbicides are estimated per year as shown in Appendix 4C-6.

As compared to present situation, future input materials increase in four times of HYV seeds, eight times fertilizer application and relatively high amount of chemicals application.

BPI recommends to renew HYV seeds in every two croppings. Then, necessary amount of seeds for the renewal is estimated at 236 tons per year.

It is expected that 24 seed producers who presently produce 496 ton (11,020 cavans) per year in the whole province of Bohol can easily cope with the demand for seeds.

In order to meet future demand for input materials some necessary marketing arrangement should be done as well as in agricultural credit institutions.

8. Agri-Institutional Organization

In order to execute the project from view point of the water management and supporting services, in general, the establishment of farmers' organization equipped with the following functions are essentialy needed;

i) to construct the on-farm facilities such as farm ditches, farm drains and farm roads at the on-farm level, to execute operation and maintenance of them and to make rotationalized water and farm management

ii) to strengthen the agricultural extension services and training of farmers; and intensifying the existing one.

iii) to promote farmers' cooperative activities;

Though there exist some farmers' organizations with such a function in the communal and private-owned pumping irrigation areas at present, they have no sufficient function to carry out integratedly the new irrigated agriculture to be introduced in the Project. Therefore, suitable farmers' organizations equipped with above functions are planned to be established in the Project intensifying the existing one.

(a) Organization for Operation and Maintenance of Proposed Facilities

In order to materialize smoothly the irrigated agricultural farming under well controlled water management and supporting services, it is necessary to establish a Irrigators' Associations with a general function as follows;

i) to promote farmers' eagerness to construct the on-farm facilities including farm land reclamation and land leveling;

ii) to assist the implementation of on-farm development with a support of land owners and farmers belonging to them under the jurisdiction of NIA and government offices concerned.

iii) to associate with the rotational irrigation systems, among which the Irrigators' Association will be organized by the farmers directly concerned to it.

iv) to promote the farm mechanization in the project, due to the expansion of an average farm size per household of 2.5 ha on completion of the project.

The relation between the Irrigators' Association and rotation irrigation systems is shown in Figure 4-2, and also the relation between each Barrio and the proposed Irrigation Association is shown in Table 4C-14, in Appendix 4C-7.

Detailed items to be carried out by the Irrigators' Association are given in Appendix 4C-7, page 2.

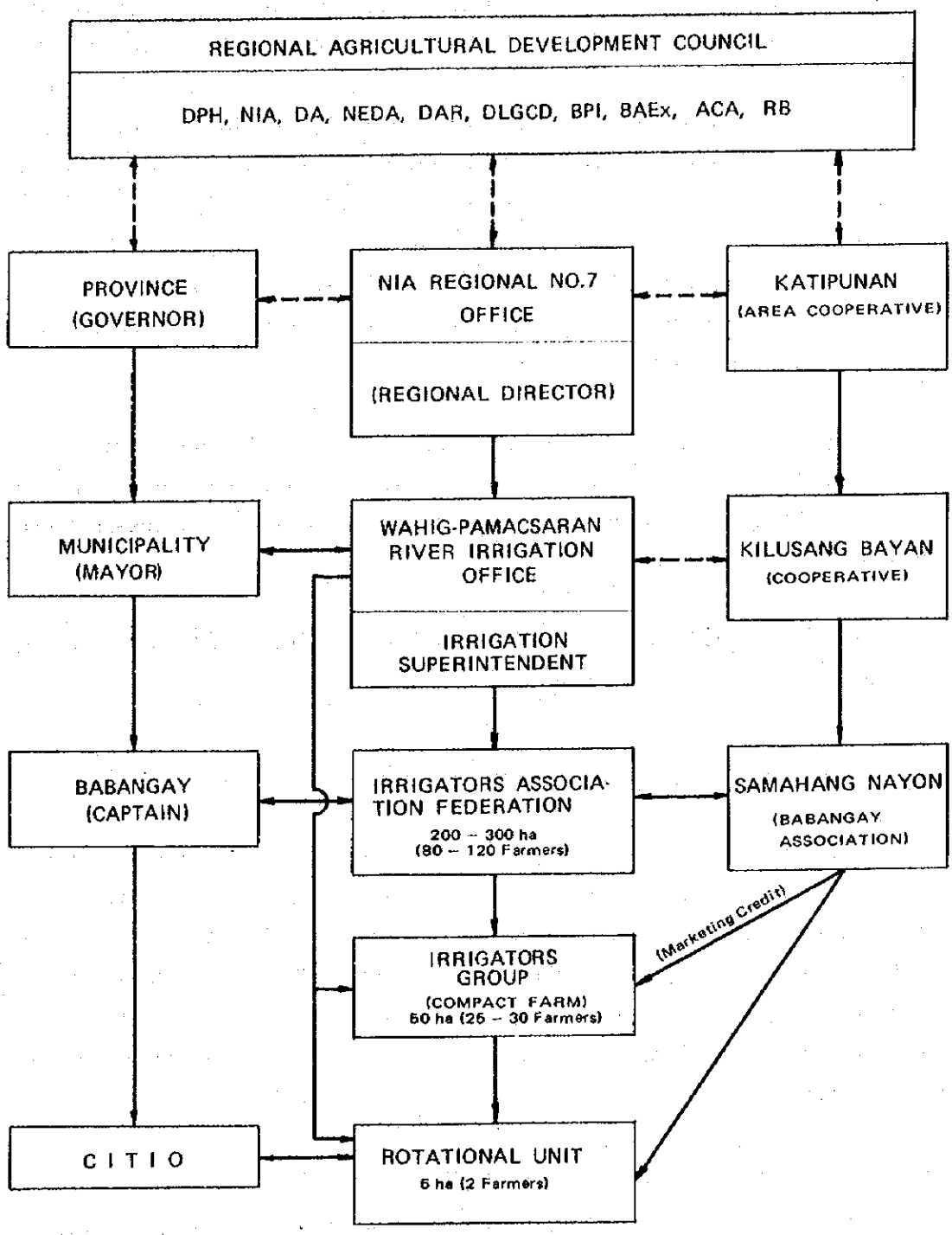
9. Supporting Services

The supporting services to be rendered under the project aim to assist farmers in accepting systematically and smoothly the irrigated agriculture with modernized infrastructural facilities so that farmers will attain the maximum result of farm land reclamation, and to make farmers promote the cooperative activity. Therefore, the following major activities of the supporting services should be carried out systematically.

(a) Acceptance of Supporting Services

The items of a great difference in the farming practices before

FIGURE 4-2. ORGANIZATION CHART FOR IRRIGATORS' ASSOCIATION



and after the project are as follows;

- Farming area per household will be increased from 1.5 ha at present to 2.5 ha on average
- Almost all area will be used for paddy field with double cropping a year
- Irrigation method will be changed to the rotational irrigation method
- High level of farming technique will be needed for handling of seeds, fertilizers and chemicals
- Farm mechanization will be introduced in accordance with expansion of cultivation area.

The present supporting services have been performed by the farmers' association in Barrio unit under the instruction of BPI and BAEx. However, in the Project such supporting services should be executed through Irrigators' Association to be established by the Project, to expect systematic and smooth acceptance for them. Furthermore, the present agricultural technicians of BPI and BAEx should be trained to meet the new farm technique such as rotational irrigation and farm mechanization.

(b) Strengthening of the Activity of Farmers' Cooperative

In order to materialize the new irrigated agriculture in the project, the following activity of farmers' cooperative such as supply of imput materials, cooperative sales, processing and transportation of products, provision of fund and promotion of saving should be carried out smoothly.

Supply of Imput Materials

Seeds:

An enlargement of rice cultivation areas and double cropping a

year in the Project will demand a lot of seeds of high yield variety, 117 tons for the wet season paddy and 120 tons for the dry season paddy. (see Table 4C-15, in Appendix 4C-7) The present supply of the seed depends upon that of BPI's seed field, but it is not enough so that it must depend upon that of the farmers' within Project Area which shall be made to be committed under a guidance of seed breeding.

Fertilizer:

The amount of fertilizer required in the Project is 1,605 tons for the wet season paddy and 1,649 ton for the dry season paddy. These amounts are about seven times of those at present. (see Table 4C-6, in Appendix 4C-7) The required funds to purchase these fertilizers will be arranged by the cooperative.

Chemicals:

It will be needed to take an adequate prevention measures for damage from blight and noxious insects both in the wet and dry season, in order to expect a high yielding. The amounts of them will become great volumes comparing with those of present. The amounts are each 154 tons for the wet season paddy and 158 tons for the dry season paddy. (see Table 4C-7, in Appendix 4C-7)

Farm Machineries:

The farm machineries in the Project are brought by the cooperatives and then lend or sold to the members of each Irrigators' group. The contents of machineries are tractor (7-8 HP), thresher (7HP) and dryer etc. (see Table 4C-18, in Appendix 4C-7)

Cooperative Sales of Products

The cooperative activities such as cooperative procurement of input material and cooperative sales of produced rice will be carried out through Samahang Nayon and Kilusang Bayan which are to be established and managed by the DLGCD. Regarding milling and storage of the increased

production of rice, they will be operated by the milling and storage facilities newly built by Samahang Nayon and Kilusang Bayan mentioned above. The amounts to be milled and storaged are estimated at about 5,180 tons, taking into consideration the total amounts of the increased production of rice about 22,340 tons (dry season paddy), consumption of rice and present milling capacity in the Project Area and its vicinity. Detail estimation of the required milling capacity is shown in Appendix 4C-7, page 9.

Budgetary Plan for Supporting Services and Promotion of Saving

A big amount of funds will be needed for farmers to purchase of required seeds, fertilizers, chemicals, farm machineries and to pay labor wages. The total amounts needed for these purposes after completion of the Project will be 21,230 thousand Pesos, which is equivalent to 9,280 Pesos per household (see Table 4C-19, Appendix 4C-7).

The promotion of saving will be done by introducing as much as possible the chit system into settlement of account for marketing of input materials and products in order to increase the cash reserve of cooperatives, and to allow farm households to draw money of more than their savings under some conditions.

(c) Education and Training of Farmers

For the irrigated agriculture with modernized agricultural infrastructual facilities, it is necessary to organized an Irrigators' Association for operation and maintenance of irrigation facilities and to strengthen the supporting services through the activities of cooperatives. For smooth execution of the Project, however, the education and training will be required not only for farmers but also leaders related to the farmers' organization and other government agencies concerned.

These education and training will be mainly conducted at the agricultural development center to be provided in the Project Area and its vicinity.

10. Community Development (Living Environmental Improvement)

Re-arrangement of village

Present farmers' houses scattering in a group of two or three households everywhere or along road will be rearranged into a community with five to ten households (equal to a Irrigators' Association), in order to have a connection with village road (Barrio road) and receive favorable benefits of drinking water and electric supply.

Standard Size of Community

(unit: ha)

Description	In Case of Five Households	In Case of Ten Houses
Area for living house	0.3	0.6
Land for livestock	2.0	4.0
Project facilities (road etc.)	0.2	0.4
Total	2.5	5.0

Road Networks

Present provincial roads within the Project Area are planned to be improved and the service and access roads will be provided along the proposed irrigation canals in the Project Area. In addition to these roads, some Barrio roads will be improved and constructed for the communication on Barrio level and transportation of products. The farm practices in the project will be mechanized to some extent so that these roads should be equipped with capability to pass at least hand tractor.

Drinking Water Supply

Supplying equipments for drinking water such as deep well and purification equipments etc. will be provided on a Barrio unit basis.

Electric Supply

Electrification of the area by this project is to be accomplished by 1979 through the Bohol Electrification Plan by NEA, and also it is possible through the electric power generation plan in this project.

For the purpose of a favorable acceptance of the electric power, it is desirable to make a group for farmers' households as mentioned above.

Community Sewage

These contaminated water from living, community and household is planned to exhaust to main sewage through road side ditch. These sewage facilities shall be planned to have enough capacity for future expansion of contamination.

D. Proposed Facilities

1. Dam

(a) Damsite Geology

Five boreholes have been drilled along the dam axis and ridges, and the permeability tests were carried out in all drillings.

According to the results of drillings, the actual foundation of the proposed Pamacsalan dam is of marly limestone, however, an alternation of sandstone and shale lies underneath the limestone in a shallower depth. The permeability of limestone is in rather higher order ranging from 1.0×10^{-5} to 6.0×10^{-4} cm/sec.

Judging from the examination of core samples, the open cavities formed by Karstism are hard to recognize and the bearing capacity of the bedrock seems to be not so high.

From the geological viewpoint, a fill-type dam with earth and rock appears the most suited type to the local conditions, when the dam height in excess of about 40 m is considered. And also, the extensive grouting with working platform or grouting adit should be considered for the limestone formation so as to obtain an impervious curtain in the dam foundation and both abutment rock. (See detail descriptions in Appendix 4D-1)

(b) Dam Site and Dam Type

1) Damsite

The proposed damsite is located on the Pamacsalan river which is a tributary of the Wahig river, and it is about 3.5 km south of Pilar.

The dam will be constructed at the upstream end of the steep-slope gorge carved in the limestone formation. The bottom elevation of the gorge at the damsite is about 193 m above sea level, and the reservoir will extend to east and south directions along the tributaries with shape of trapesoid in reservoir filling.

When the dam is constructed in this site, countermeasure of water tightness for the leakout water through the limestone formation should be considered without regard to the type of dam.

2) Dam-type

Taking into account the topographical, geological and hydrological conditions at the proposed dam site, two different types of the dam were considered. They are concrete gravity and fill-type dams. According to the result of reservoir operation studies, the height of Pamacsalan dam was decided at about 68 m.

From the topographical point of view, it was considered that the concrete gravity type dam was the most suitable to the shape of gorge and distribution of outcrops around the damsite. However, the results of compressive strength test for the foundation rocks led to rule out the concrete dam due to the lack of bearing capacity and shearing friction resistance in the bedrock, especially at the river bed. With respect to the fill-type dam, the loads from dam body is transmitted to a wider area of foundation than those of concrete dam and therefore the dam can be built with safety.

Whereas, a center core type of rock fill dam with crest elevation at 251.5 m was selected as the most suitable type for the Pamacsalan Dam. However, for the low dam less than about 40 m, the concrete

gravity type dam might be found feasible (Refer to detailed descriptions in Appendix 4D-3).

(c) Dam and Foundation Treatment

The proposed dam is a center core-type rock fill with about 68 m height from the deepest core zone base and the crest length is about 148 m excluding the spillway in the right bank. Total embankment volume is about 590,000 cu.m including the upstream coffer dam which will form a part of the main dam body. Total volume of the impervious material for the core zone is about 91,000 cu.m.

1) Foundation Treatment

The excavation depth of the entire dam base, in general, will not exceed one meter including the removal of all vegetal soil. However, a deeper excavation of 2 to 32 m is designed on the core zone base, so as to reach sound rock foundation and keep away from the differential settlement. The longitudinal slope of core zone base should be kept less than one vertical to 0.75 horizontal in order to avoid the shearing crack from the differential settlement in the core zone.

Taking account of the lithic properties of the limestone formation, the extensive grouting should be considered for foundation rock. After the excavation is completed, the core zone base will be treated with blanket grouting, in order to improve the bearing capacity with uniformity and make sure the subsequent high pressure curtain grouting. The curtain grouting should be performed with several stages from the core zone base, so as to obtain an impervious curtain in the dam foundation rock. Depth of curtain grouting should be reached into sufficient sound rock and joints, fractures and Karstism marks are to be sealed. Special treatment for the fault zone at the river bed should be considered with replacement method covering the core zone base. Auxiliary impermeability grouting should be performed for the spillway and diversion tunnel to be connected with the dam curtain.

2) Embankment Materials

The materials available around the damsite are an important factor in dam designing for fill type dam. An available borrow area for impervious material is found in the hills near the right abutment within 0.5 to 1.0 km from the damsite. The hills are covered with residual clayey soils of comparative thick, originating from decomposition of limestone formation.

Limestone rock is abundant around the damsite, and both abutment ridges higher than elevation 251.5 m were selected for the quarry site on account of economical exploitation and as the grouting platform for the countermeasure of water tightness on the dam abutments. According to the field survey, the limestone formation seems apparently sound, massive and less fractured, however, considerable parts tend to break in small fragments with good percentage of fine materials during the operation of the exploitation and embankment. The design values of embankment materials as derived from the tests and data are summarized in the following table:

Design Values of Embankment Materials

Materials	Density		Shearing Strength				
			U-U test[6]		C-U test[7]		
	γt[1] (t/m^3)	γsat[2] (t/m^3)	ϕ[3]	C[4] (t/m^2)	ϕ[3]	C[4] (t/m^2)	K[5] (cm/sec)
Impervious	1.87	1.91	5°40'	6.60	6°40'	6.60	6.9×10^{-9}
Transition	1.70	1.88	35°00'	0.00	35°00'	0.00	-
Rock	1.61	1.87	39°00'	0.00	39°00'	0.00	-

[1] wet density, [2] saturated density,
[3] angle of internal friction
[4] cohesion
[5] permeability coefficient
[6] values use for the conditions during construction or immediately after completion of embankment
[7] values use for the conditions at full or rapid draw down of the reservoir.

3) Dam Design

A zone type of rock fill dam is adopted as the most suitable dam for this site on account of the economical construction and available materials. The elevation of dam crest is designed by adding the free-board which is decided by the detail study to the full water surface (NWS) level of reservoir (see Appendix 4D-4). According to the results of stability Analysis for the dam body, the upstream and downstream slopes of dam are 1 vertical to 2.5 and 2.0 horizontal respectively as shown in the attached Drawing No.002 (see detailed descriptions in Appendix 4D-5).

The proposed dam has a rather thin impervious zone, having 1 vertical to 0.25 horizontal of both slopes taking into account diminution of the foundation treatment and countermeasure for the earthquake. The transition zones are provided both in upstream and downstream of the core, so as to obtain a gradual transition between the impervious core and outer shell of rock zone. The outer shell of rock zones are formed with quarried relatively sound and massive limestone rocks. The riprap with one meter thickness is provided on the upstream surface in order to dissipate the wave energy and decrease the uprushing height of wave from the reservoir, and the minimum size of 30 cm sound rocks are to be dumped to the outer shell face.

Both upstream and downstream surface of core, the filter zone shall be located with three meters thickness in order to prevent washing-out of fine materials contained in the core zone, and to permit seepage water to flow out of the zone.

(d) Spillway

The results of comparative study, a three-gate open-type spillway is adopted on the right abutment of the dam from viewpoints of non-resistance of filltype dam against overtopping from unexpected flood, hydraulic characteristic itself and diversification of risk by the gate control.

1) Gated Spillway

The design flood discharge of 600 cu.m/sec is adopted for the spillway and this value is based on a discharge of 20 percent more than a return period of 100 years flood discharge. The three radial gates of 6.4 m height and 6.73 m width are installed at the crest portion. At the downstream of the gate portion, a concrete-lined chute of 24.6 m width is constructed to connect a terminal stilling basin to prevent excessive erosion and scouring for the downstream of damsite.

For the gate maintenance or overhauling, the spillway can be temporary closed by means of stoplogs with needle beams.

2) Ultimate Flow-out Capacity

An unexpected flood discharge would flow into the reservoir and the discharge capacity of spillway has been estimated as shown in the following table with reservoir routing.

Description	Unexpected Discharge (cu.m/sec)			
	700	800	900	1,000
Return period (years)	210	430	890	1,800
Rise water level from NWS (m)1/	0.25	0.50	0.73	0.98

1/ full water surface EL 248.5 m

Judging from the above table, the Pamacsalan reservoir has a large reservoir routing. In defining that the ultimate flow-out discharge of spillway occurs when is the reservoir water surface reaches the dam crest elevation, the discharge will be 1,847 cu.m/sec and this value may be indefinite with return period (See detailed descriptions in Appendix 4D-6).

(e) Diversion Facilities

During the construction of dam, the Pamacsalan river flow will be diverted through a tunnel with concrete-lined which is provided on the

right abutment of the dam with five meters of inside diameter of the horse-shoe shaped. This diversion facilities will be used for the outlet facilities from the reservoir after the completion of the dam.

About 21 m height of coffer dam should be provided at the upstream of the dam and smaller temporary downstream coffer dam is also necessary in order to fully protect the construction site of the dam. The upstream coffer dam is designed as a part of the main dam body, so as to diminish the overall embankment volume.

The design flood discharge for the diversion system such as tunnel and coffer dam was computed at 400 cu.m/sec with a return period of 10-years, however, the diversion capacity discharge is decided at 155 cu.m/sec with reservoir routing which is provided by an upstream coffer dam when a flood discharge of 400 cu.m/sec flow into the reservoir. (See detailed descriptions in Appendix 4D-7)

(f) Irrigation Outlet

After completion of the construction of dam, the diversion inlet should be plugged, and irrigation water will be released from a drop inlet intake with trash-rack which is located near the entrance part of diversion tunnel with an elevation around 205 m.

A steel conduit one meter inside diameter with circular shaped will be installed in the downstream part of diversion tunnel. For the control equipment of irrigation demand, the cone valve is to be adopted as it functions both for discharge control and energy dissipation at the end of diversion tunnel.

During the operation of the hydro-electric power plant, the water will be diverted from the irrigation conduit with a bifurcation pipe to the plant and this released water will be used for irrigation purpose again.

(g) Countermeasure for Leakage from Dam Abutment

Both dam abutments are composed of limestone formation and on the left abutment, the Karstism marks such as cave, sinkhole and depression are found. As mentioned above, the storage water may probably be leaked out through the limestone formation unless any countermeasure for the leakage in reservoir filling. And as a countermeasure, a grouting by injection method with working platform or grouting adit was adopted.

Usually, it is difficult to find out the leakage path through the limestone formation before reservoir filling, so that additional countermeasure should be considered during or after reservoir filling due to the data obtained from observation of the measuring facilities such as an extensive net of piezometer holes where the groundwater levels will be monitored.

It is very difficult to define the scope of countermeasure for leakage through the dam abutment, however, it will be assumed by reference to the Creep-ratio which is used for the foundation treatment of usual dams. (See detailed descriptions in Appendix 4D-8)

Design of Pamacsalan dam is shown in Drawing No.001 to No.003.

2. Diversion Dam

Malinao Diversion Dam

The Malinao diversion dam is located more or less 200 m down stream from the confluence of Wahig and Pamacsalan rivers, and about 200 m upstream from the bridge across the Wahig river in Pilar, about three kilometers north-east of Sierra Bullones.

The two roller gates with seven meters high and 13 m wide named flood gate and a 10 m high and 13 m wide roller gate with flap named flash gate are installed on the overflow section. The design flood discharge of 1,100 cu.m/sec. is considered for the flood way. At the

downstream of the gate, a terminal stilling basin type of energy dissipator is constructed.

The three sluice gates with 1.5 m high and 1.5 m wide are installed on the right bank of the dam for the intake facilities of main canal. The proposed water surface elevation of canal head is decided as EL 145.00 m depending on the topographic condition of Project Area. The maximum capacities of main canal will be 6.79 cu.m/sec in order to serve the Project Area of 4,800 ha. The length of diversion dam is 51.0 m.

About five meter high earth dike paved by grouted riprap are provided on both abutments to keep the normal water surface elevation as EL 152.0 m. The bank top will be used as operation and maintenance road and connected by the operation bridge.

Wahig Diversion Dam

The Wahig diversion dam is located on the Wahig river in Barrio Danicop about 4 km south-west of Sierra Bullones. It is an ogee-shape overflow type dam with a crest length of 20.0 m and a dam height of two m. An intake with a capacities of 0.60 cu.m/sec will be constructed on the right abutment to serve the irrigable area along the Wahig river which are presently served by the several existing blash dams. The proposed intake water surface elevation would be required as EL 218 m. The wing wall on the left and right abutments would be constructed by concrete as five meter long for upstream of dam axis and 30 m long for downstream of dam axis. A 1.4 m high and two meters wide sluice gate would be installed for the flash way beside the intake gate.

Pamacsalan Diversion Dam

The diversion weir across the Pamacsalan river is a simple shape, overflow type concrete dam with a crest length of about 20.0 m long and a dam height of one meter high. It is located approximately 1.2 km downstream of the proposed Pamacsalan damsite in Barrio Pamacsalan about 2.5 km south-east of Pilar. Two headgates with a capacities of 0.15 cu.m/sec and 0.03 cu.m/sec will be provided on the left and right

abutments respectively in order to serve about 120 ha of areas which are presently irrigated by the existing communal irrigation systems. The crest elevation of dam or intake water surface elevation will be EL 178.5 m.

The designs of diversion dams are shown in attached Drawing 004 to 007.

3. Irrigation Canal

(a) Canal Alignment

After being familiar with the terrain and general direction of slope in the service area, layout of the canal network was plotted on a 1 : 4,000 topographic map. The canal system was planned in such a way that a maximum area could be benefited at a reasonable cost or that would have full command of the project area.

Proposed Length of Irrigation Canals

Description	Canal Length (m)	Service Area (ha)	Intensity (m/ha)
Upper Area			
Wahig Area		400	
Main Canal	6,380		
Lateral Canal	7,500		
Sub-total	13,880	400	34.7
Pamacsalan Area			
Main Canal (L)	3,150	120	
Main Canal (R)	900		
Sub-total	4,050	120	33.8
Lower Area			
Main Canal	27,360	4,800	
Lateral Canal	46,190		
Sub-Lateral	39,860		
Sub-total	113,410	4,800	23.6
Total	131,340	5,320	24.7

(b) Canal Section

Depending on the stability of embankment material in the Project Area, only an unlined earth canal is designed for the conveyance water purposes. Its section is trapezoidal in form and designed based on Manning's Open Channel Formula, considering the topography and man-made features. It will have a base-depth ratio of 2.5, side slope of 1.5:1 and coefficient of roughness "n" of 0.025. A freeboard of 0.4 times the depth of water or a minimum of 30 cm is provided to give a sufficient height for checking purposes.

The velocity of water in the canal as determined from computation by the open channel formulas should be checked whether it is within the critical velocities of sliting or scouring. Usually the velocities vary from 0.3 m/sec to 1.0 m/sec depending on the size and slope of canal. The flattest slope is 0.0002 for main supply canal with discharge of 10 cu.m/sec or more and the steepest slope is 0.003 for canals with discharge of 0.5 cu.m/sec or less. A slope of 0.002 is the steepest adopted for canals with discharge between 0.50 to 1.00 cu.m/sec.

Design criteria and proposed canals are given in Appendix 4D-10.

(c) Related Structure

Conveyance Structure

The topographic condition and existing man-made features in the proposed area require the construction of conveyance structures along the canal network. These structures will simply allow the irrigation water to flow smoothly from the headgates up to the end checks.

Inverted siphons would be used in crossing rivers and creeks when the maximum flood elevation is close to or above the canal grade lines. In case where the maximum flood elevation is 0.90 m or more below the said grade line, a flum may be used. Road crossings would be provided when the canal passes through an existing or proposed roads. Bench flumes and chutes or drops may be needed to convey water along steep

sidehills and to safely bring the water down a hillside or to a lower elevation respectively.

Thresher crossings would be placed at convenient points where there is no road crossings. It is usually spaced for every 200 to 300 m of canal in residential areas and every 400 to 500 meters in non-residential area.

Regulating Structure

In some points along the canal system, especially at the headgates of lateral and sub-lateral canals, regulating structures would be provided to raise the canal water elevation higher than that in the case the water flowing is less than the designed discharge. An example of this is a check structure constructed across the main or lateral canals, in order to raise the water surface elevation, and allow the desired irrigation water to enter into the lateral or sub-lateral canal.

Projective Structure

The canal system would be protected with structures that will prevent excess water inside or outside the canal from destruction of the canal embankment. Spillway structure would be provided so that the excess water in the canal will just spill into the drainage canal or at designated locations. Small waterways would be provided with drainage structures such as drainage siphons, culverts and paddy drains.

The choice of drainage structure is guided by the elevation of the waterway. When the bottom of the waterway is below the bottom of the canal, the culvert is the appropriate structure; when it is 0.3 m below up to a point just below water surface in the canal the drainage siphon would be used; and when the bottom of the waterway is above the full water supply in the canal, the paddy drain is the right structure to be provided.

Typical design of the canals and related structures mentioned above are attached in Drawing No. 008 to 022.

4. Drainage Canal

(a) Canal Alignment

A layout of the drainage canal network was plotted the topographic map of 1:4,000 in scale prepared by NIA after a field investigation of the Project Area. Existing waterways such as rivers and creeks, etc. will be utilized as main or lateral drainage canals. Most of these natural channels have to be desilted and widened based on the designed discharge capacities.

The estimated length of proposed drainage canals are shown in the following table.

Description	Proposed Canal Length			
	Without Improvement (m)	With Improvement (m)	New Construction (m)	Total (m)
Upper Area				
Wahig area				
Main canal	-	-	-	-
Lateral canal	-	6,400	-	6,400
Sub-total	-	6,400	-	6,400
Pamacsalan area				
Main canal	-	-	-	-
Lateral canal	-	2,000	-	2,000
Sub-total	-	2,000	-	2,000
Lower Area				
Main canal	1,800	16,000	-	17,800
Lateral canal	10,500	35,400	25,700	71,600
Sub-total	12,300	51,400	25,700	89,400
Total	12,300	59,800	25,700	97,800

The intensity of drainage canals in the project area is 18 meters per hectare. Although this value does not satisfy the NIA criteria, it is considered to be reasonable because of the steep topographical condition. (See Table 4D-5 in Appendix 4D-11)

(b) Canal Section

Based on the topographical map with a scale of 1:4,000, the maximum drainage areas are estimated about 5,800 ha for the main drainage canal and about 500 ha for lateral canals, respectively. The capacities of these canals were calculated in the range of 0.3 to 34 cu.m/sec based on the unit area discharge mentioned previously, and the catchment area in the layout map. The drainage canal is an earth canal of a trapezoidal open-type designed based on NIA criteria. It will have a base-depth ratio 0.8, side slope of 1:1 and the coefficient of roughness for the Manning's formula "n" of 0.025.

The permissible velocity of water in the drainage canals is within 1.0 m/sec which is determined as non-scouring velocity. The typical cross-section of drainage canals is shown in the attached Drawing No.024.

(c) Related Structure

Drainage drops will be required to protect canals from scouring or erosion caused by flood. The structure is constructed mostly of grouted riprap to minimize the construction cost. The total number of structures is estimated about 340 units because of steep slopes which prevail in the project area.

Typical design of the structure is shown in the attached Drawing No. 025.

5. Road Plan

The types of road would be provided in the Project Area, namely: (a) service road to be constructed along the main canal and selected lateral and sub-lateral canals; and (b) access road to connect two service roads or service road and provincial or barrio roads.

Services roads along the main and lateral or sub-lateral canals would be 6.0 m and 3.5 m wide respectively; except the trank road

along the lateral or sub-lateral canals connecting the two provincial roads which is also 6.0 m wide. The cross-section of the road have a surfacing of 15 cm thick of base coarse and selected borrow of 20 cm thick. The existing provincial and barrio road will be improved based on the criteria used by the Department of Public Highways.

Total length of the proposed service and access roads are shown as follows:

Proposed Road Length

Type	Remarks	Length (km)
Service Road		
Type A	along the M.C.	22.9
Type A	along the L.C.	4.7
Type B	along the L.C.	66.4
Sub-total		94.0
Access Road		
Type A	improvement of provincial road	17.7
Type A	new construction	0.5
Type B	improvement of barrio road	2.4
Type B	new construction	3.7
Sub-total		24.3
Total		118.3

Note: Details are indicated in Appendix 4D-12.

Road intensity in the project is estimated at 21.8 m/ha, which will satisfy the NIA standard.

Typical design of the proposed road section is shown in the attached Drawing No. 026.

6. On-Farm

As there are no limitation factors specified for farm land reclamation because the soils in the Project Area are classified as clay or clayey loam according to the soil investigation, the criteria used in the Bureau of Soils in terracing along the contour lines will be adopted to reclaim hilly land. The proposed areas to be reclaimed are estimated at about 3,440 ha., which are almost classified in the land category of grasslands or upland fields.

(a) Model Design for Sample Area

In order to give the shape to the concept of the proposed terminal facilities, the model design of roads and irrigation & drainage canals as well as land parcelling were actually carried out at the two sample areas. Furthermore, the required costs for on-farm development were estimated and their results were applied for the design of on-farm development works in the whole Project Area.

Determination of Sample Area

The sample areas are located at the central part of the Project Area which has natural conditions in topography prevailing in the Project Area. One sample area (Area "A") is located on the area served by lateral irrigation canal of N-2 near Barrio San Isidro, and the other sample area (Area "B") is located on the area served by lateral irrigation canal of B near Barrio Estaca. An acreage of each sample area is 194 ha of Area "A" and 126 ha of Area "B".

Land Parcelling and Typical Design

The land parcelling in the sample areas was executed based on the topographic map with scale of 1:2,000 prepared by NIA, and as a result, an average acreage of suitable one rotational block is decided approximately at 25 ha depending upon the topographic conditions.

Estimation of earth moving volume and design of facilities were also made in accordance with the criteria. The result of calculation is

shown below. Typical layout for sample areas and design of related facilities is shown in attached Drawing No. 027 to No. 032.

Result of Typical Design in Sample Area

Description		Area "A"	Area "B"	Average Total	Average Per Ha.
1. Area (ha)					
Gross area		194	126	320	
Net area		134	98	232	
2. Land levelling for terracing ('000 cu.m)		75.2	83.4	158.6	0.684
3. Major on-farm facilities					
Main farm ditch	(m)	4,390	3,019	7,409	31.9
Supplementary farm ditch	(m)	10,080	8,197	18,277	78.8
Farm drain	(m)	3,693	3,451	7,144	30.8
Farm road	(m)	293	1,198	1,491	6.4
Turn-out	(place)	5	4	9	
Division box	(place)	25	20	45	
End check	(place)	5	4	9	
Farm road crossing	(place)	23	15	38	
Drop	(place)	21	8	29	

Note: Details are shown in Appendix 4D-13

The average intensities of following on-farm facilities are: farm ditch 110.7 m, farm drain 30.8 m, and farm road 6.4 m respectively.

(b) On-Farm Facility in the Whole Project Area

As mentioned previously, the sample estimation at selected two areas are applied to the whole Project Area to estimate the required on-farm facilities and costs.

7. Electric Power

(a) General

The Power plant will be constructed on the right side, down

stream from the dam. The slope of the stream from the dam to the proposed power house is estimated to be 1:30, but farther down stream from the power house is 1:100. This slope is so gentle slope that development of waterhead would be unfavorable. If the Power house is situated near the outlet of the by-pass tunnel in this area, on base rock exposed on the river bed, ground condition would be more suitable.

The penstock will pass through the by-pass tunnel to down-stream and fork into two branches, of which one flows to the irrigation line and the other flows into the power house. The power house with two stories will be made of reinforced concrete.

The tailraces are also made of reinforced concrete and frash racks and stoplogs will be furnished for protection against entrance of sand and driftwood. Each turbine set should be so equipped for easy maintenance of the tailrace. A sub-station for distribution of power will be installed outdoors.

(b) Power Plant Facilities

Proposed power plant facilities are as follows:

Hydro turbine

No. required	2 sets
Max. discharge	1.5 cu.m/unit
Max. total head	73.5 m
Turbine output	900 kw/unit
Type	Francis Horizontal shaft
Rated speed	1,200 r.p.m.
Included auxiliary equipment	L.S.

Synchronous generator

No. required	2 sets
Rated voltage	3,450 V
Max. continuous rating	850 KW, (1,062.5 KVA)
Frequency and speed	60 Hz/1,000 r.p.m.
Rated power factor	Lagging 0.8

Switchgear and control panel

Metal-enclosed cubicle

Overhead traveling crane

Lifting weight	max. 10 tons

69 KV sub-station

1) Main transformer

No. required	1 set
Rated voltage	3.45/69 KV
Rated capacity	2,000 KVA

2) 69 KV equipment
   - 1 - Circuit breaker
   - 1 - Isolator (Disconnect switch)
   - 1 - Potential transformer
   - 1 - Structures, insulators, conductors and earthing materials
   - 1 - Foundations and fences

Power house

Reinforced concrete	20m x 8m x 14m (height)

Electrical equipment

Lighting and socket
Cable and conduit pipe
Exhaust fans

Transmission line

1) 69KV line to Carmen

Poles	wood, height: min 15 m
Wire	ACSR 120 sq.

2) 3KV line to Marinao diversion dam

Poles	wood, height: min 10 m
Insulated wire	6KV OE 5 mm

Penstock

Main penstock	dia. 1,000 mm

E. Cost Estimate

The total investment cost, including the cost for price escalation during the construction period, is estimated at about US$43.6 million of which US$25.2 million will be foreign currency component and US$18.4 million will be an equivalent to local currency component. The following table shows the breakdown of the investment by major items (See Appendix 4E-1).

Investment Cost of the Project

(unit: US$'000)

	Description	Foreign Currency	Local Currency	Total
1.	Civil Works	6,500	7,470	13,970
2.	Land Acqusition and Compensation	-	860	860
3.	Construction Equipment	6,830	70	6,900
4.	Agricultural Development	-	200	200
5.	Operation and Maintenance	-	430	430
6.	Project Facility	130	630	760
7.	Project Administration	1,080	770	1,850
8.	Consulting Services	1,010	180	1,190
	Sub-total	15,560	10,610	26,170
9.	Contingency	2,330	1,590	3,920
	Sub-total	17,890	12,200	30,090
10.	Price Escalation	7,350	6,210	13,560
	Grand Total	25,240	18,410	43,650

The project cost per hectare is estimated at US$4,480 without hydro-power (See Table 4E-4 in Appendix 4E-1) and US$4,310 allocated with hydro-power, based upon the following conditions; i) depreciation cost of construction equipment are involved in the unit cost of civil works instead of the cost of construction equipment, and ii) price escalation is not included.

The annual disbursement schedule for the investment cost is shown in Table 4E-5 in Appendix 4E-1). The cost estimates of the Project were made in the following ways:

(1) Civil Works

The cost of civil works consists of the construction cost on engineering works for the project, which are estimated on the basis of unit cost including construction materials, fuel and oil, and repair of equipment and labor cost. The depreciation costs of the imported construction equipments and workshop equipment are not included in the items of the civil works.

The major items of engineering works are as follows:

Dam:
to include diversion, foundation treatment, embankment of dam body, spillway excavation and concrete, gates, intake facilities and relocation and access road.

Diversion Dam:
to include foundation treatment, concrete, gates, earth dike and intake facilities.

Irrigation Canal:
to include earth works of main, lateral/sub-lateral canals and related structures.

Drainage Canal:
to include earth works of main and lateral canals and drop structures.

On-Farm:
to include land levelling and terracing, and on-farm facilities such as farm ditch, farm drain and farm road.

Road:
to include the construction of service and access roads and improvement of provincial road.

Hydropower:
to include earth and concrete works to construct the power station, equipment such as turbine, generator, crane and transmission line.

Pre-Engineering:
to include survey works for major facilities such as Pamacsalan dam, diversion dams and irrigation and drainage facilities, hydrological observation and agricultural survey of which descriptions are given in Appendix 5B-1.

(2) Land Acquisition and Compensation

Land acquisition cost for project facilities and land compensation cost for reservoir areas of Pamacsalan dam and Malinao diversion dam are estimated. (See Appendix 4E-2)

(3) Construction Equipment

The construction equipments and spare parts are purchased by government in the lump except small equipments which are able to purchase in Philippines.

The cost of construction equipment and spare parts are estimated on the basis of CIF Tagbilaran in Bohol, and exclusive of the custom duties and the other local taxes to be imposed in Philippines.

Unloading cost at Tagbilaran port and transportation cost from port to construction site are added to above purchase cost.

(4) Agricultural Development

The costs required for agricultural supporting services are included.

(5) Operation and Maintenance

The project cost involve operation and maintenance cost for three years from FY 1983 to FY 1985, which requires to operate and maintain

the project facilities constructed already during the construction periods.

(6) Project Facility and Administration

Project Facility: to estimate the required cost for project facilities such as buildings, furnitures and equipments.

Project Administration: to evaluate the overhead charge for government staffs to be engaged in the newly organized Project Office.

(7) Consulting Services

Engineering fee for consulting services include the implementation of final design and supervision of the Project (See Appendix 5D-1).

(8) Contingency

Allocation for contingencies is included in the total base to cover minor differences in actual and estimated quantities, unforseeable difficulties in construction, possible changes in plan because of site conditions or uncertainties regarding foundation conditions. The adopted percentages of contingencies on each item for this project are 15 percent.

(9) Price Escalation

Price escalation of eight percent per annum for both the foreign and local currency portioned is allowed.

(10) Unit Cost

The cost of construction materials to be used in the Project are estimated on the basis of the prevailing prices as of January 1977, prepared by NIA. Especially, ANFO (Ammonium Nitrate-Fuel Oil) and P.S. Slag Cement (Portland Blast-Furnace Slag Cement) are estimated

based upon the inquiring cost at market. The labor cost is estimated on the basis of the wage rate of laborers for every type of job used by NIA.

The unit cost for construction under contract basis includes ten percent for profit, miscellaneous, and overhead respectively as well as three percent for taxes.

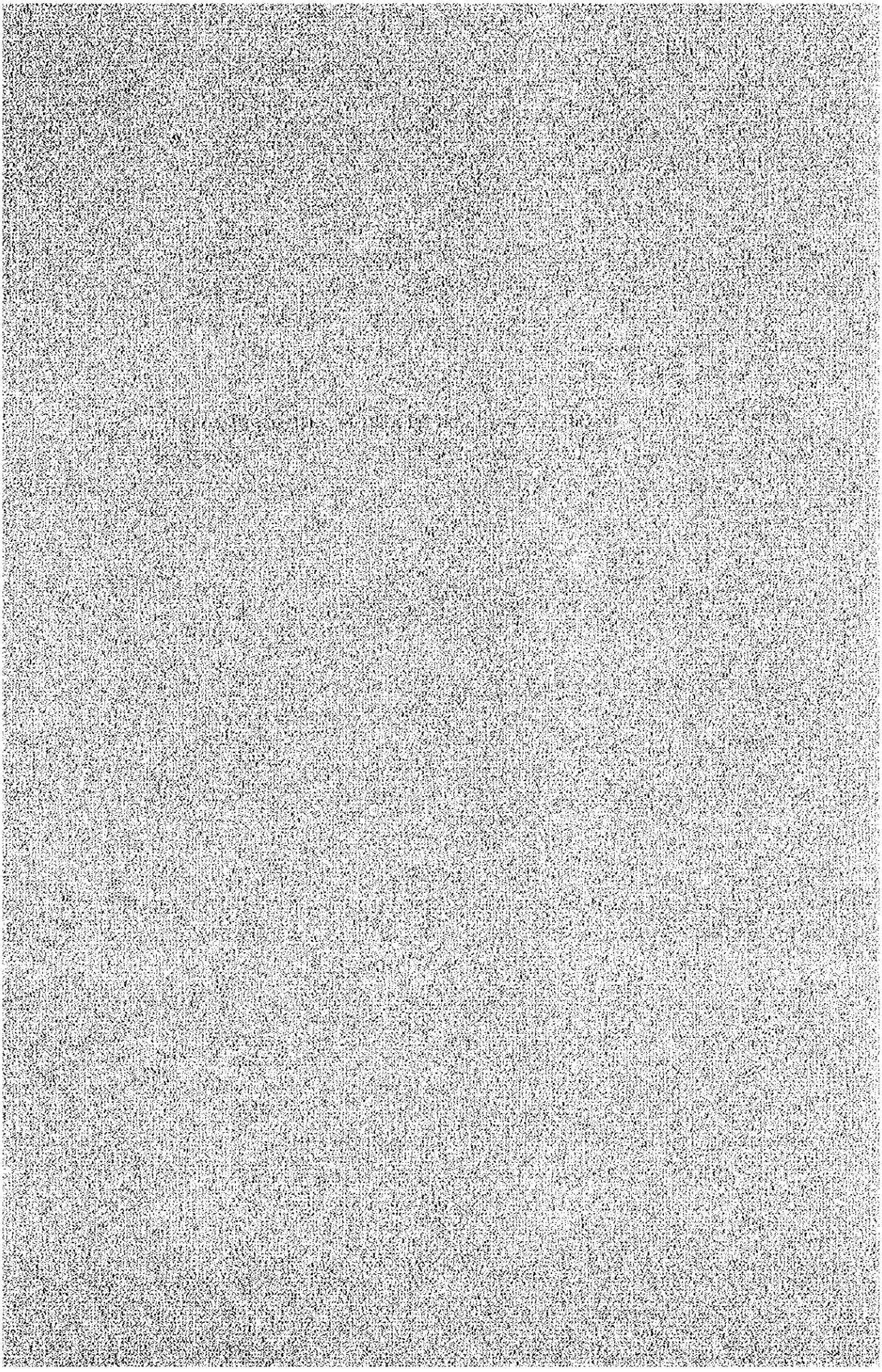
(11) Foreign and Local Procurements of Material

The cost such materials as cement, fuel oil, deformed-bars, etc. are divided into two portions of foreign and local procurement as shown below:

Item	Foreign Procurement (%)	Local Procurement (%)
Cement (Portland)	20	80
Cement (P.S. Slag)	80	20
Fuel Oil	50	50
Deformed bar	50	50
Explosive (Dynamite)	-	100
Explosive (A.N.F.O)	100	-
Fuse & Cap	100	-
Bit & Rod	100	-

All the construction equipment, workshop equipment, other imported equipment and material mentioned above are employed by the foreign exchange component, whereas the local currency component consists of all the costs of labor, operation and maintenance of equipment and local materials.

CHAPTER V. PROJECT IMPLEMENTATION AND OPERATION



CHAPTER V. PROJECT IMPLEMENTATION AND OPERATION

A. Executing Agency and Coordination

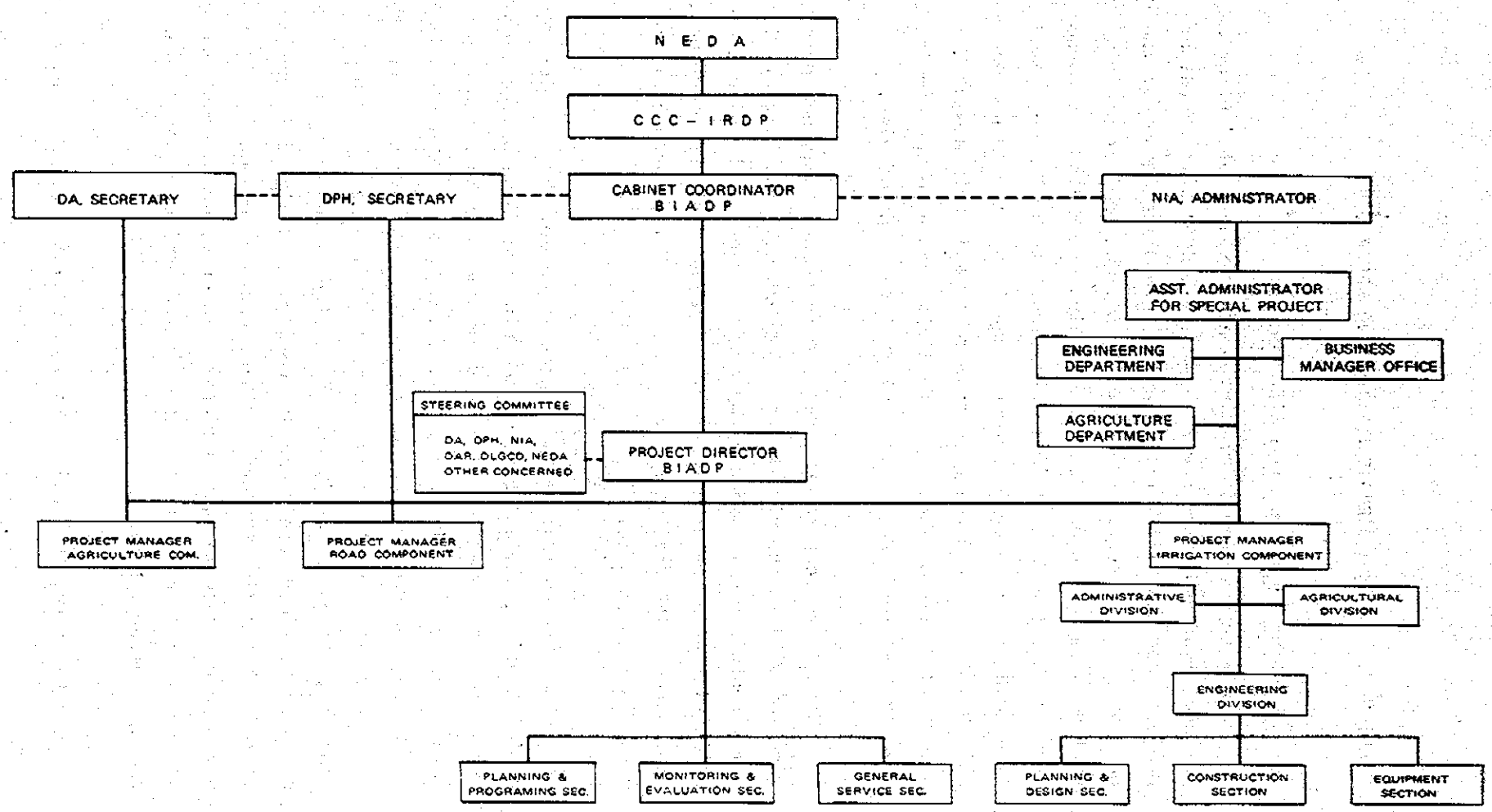
Since this scheme is the integrated project of irrigation, agriculture, road and hydro-power components, NEDA will coordinate the Project, and NIA will function as the Executing Agency of the Project. According to the requirements from NEDA, the Project Steering Committee will be organized under Cabinet Coordinator of BIADP, in order to carry out smoothly the Project implementation. It will make a good coordination among the related Departments and Authorities concerned such as NIA, DPH and DA, and requests them to extend their assistances and advices directly or indirectly to BIADP, and also the committee will give advices to BIADP from administrative point of view.

With these cooperation, BIADP with specifically nominated Project Director will be the direct executing agency. The Project Director is fully responsible to execute the project works in keeping a close coordination among related Departments and Authorities concerned, and also directs the Project Managers who are fully responsible to the works in the job site.

Under the control of the Project Manager, the Division such as Administration, Agriculture, Engineering and so on will, in case of irrigation, be organized. These Divisions will keep close cooperation each other as shown in Figure 5-1, which indicates the proposed organization for the Project implementation. In the organization, the Engineering Division would be responsible for the preparation of plans, programs, design and estimates of the facilities as well as revisions dictated by field conditions of those works designed in the central office. The Administrative Division would be responsible for personnel and records management, accounting, property, procurement and other services. The agricultural phase of the project would be handled by the Agricultural Division.

Furthermore, the Project Manager will try to keep close contact

FIGURE 5-1. PROPOSED ORGANIZATION CHART FOR PROJECT IMPLEMENTATION



with local offices of the related departments and autorities so that the Project works may be smoothly executed.

B. Construction Method and Schedule

1. Construction Method

The Project includes many kinds of civil works such as construction of dam, diversion dam, irrigation and drainage canals, roads, on-farm and hydro-power.

There are two ways to execute such civil works, execution by force account and contract basis. The contract basis will be adopted in the Project due to the following reason:

- Shortage in number of government-owned construction equipments
- Shortage in number of engineers and skillful equipment operators in the related organization
- Intention to bring up the local contractors.

Under the circumstances, the local contractors will execute the construction works, for which the equipment and materials to be imported by the Government will be supplied.

2. Construction Schedule

The Project Area has a total acreage of about 7,300 ha, which would be divided into two blocks, Upper Area and Lower Area, from view point of the topography as well as the proposed irrigation and drainage systems.

Since the civil works included in the Project are of considerably large scale, the construction period will inevitably depend upon the work volumes and climate conditions.

The construction period is scheduled for seven years from FY 1979 to FY 1985 including the final design through the years of 1979 to 1980, and the construction of the facilities will start in FY 1981 and will complete in FY 1985. The construction of Malinao diversion dam will be commenced in FY 1981 in one advance, prior to the commencement of the construction of the other major facilities such as Pamacsalan dam, irrigation and drainage canals, on-farm development and so forth, which will start from FY 1982. (See Figure 5-2) Out of these constructions, the reclamation areas in each year for the on-farm development in the lower area are planned based on the consideration for the expectable irrigation water after implementation of the Malinao diversion dam and construction volumes, that is, about 1,360 ha in 1982, 1,390 ha in 1983, 1,200 ha in 1984, and 850 ha in 1985 respectively.

Construction planning of the major civil works is given in Appendix 5A-1. For the completion of the Project in FY 1985, due consideration shall be paid on the following items.

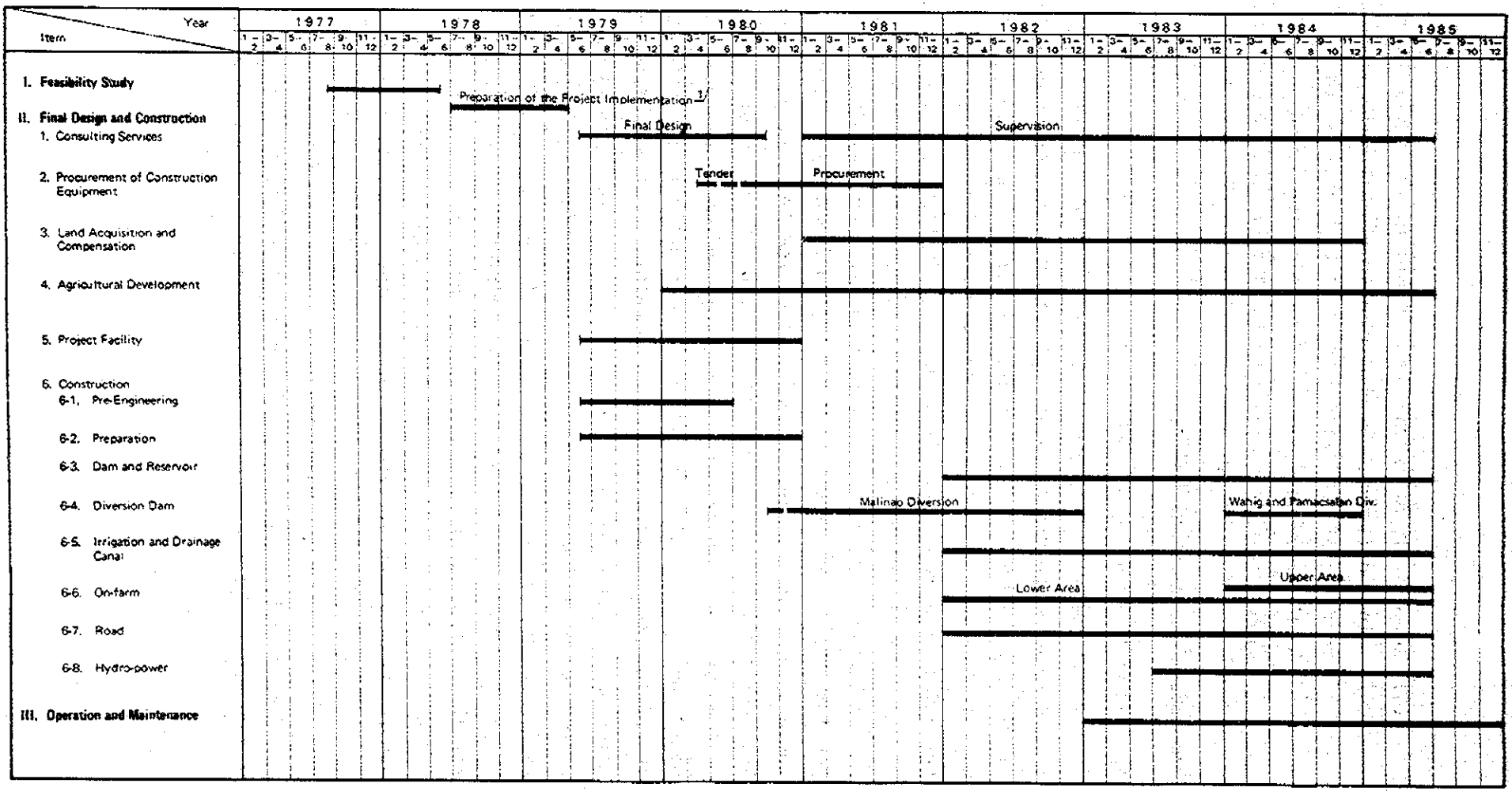
(1) Final design for the Project will be finished in September 1980 and during that time the tender for the procurement of the construction equipment and materials shall be finished.

(2) Surveying and geological investigation for the proposed dam, diversion dam, irrigation and drainage canals, on-farm facilities, other main facilities and also soil test shall be finished for the implementation of the final design. (See Appendix 5B-1)

(3) Construction of diversion dam will be executed in advance to those of other facilities, in order to expect the attainment of quick yielding of agricultural products.

(4) Construction of dam including hydro-power, which are the major structures in the Project, will be completed in the middle of FY 1985 behind two and half years of diversion dam completion.

FIGURE 5-2 CONSTRUCTION SCHEDULE FOR THE PROJECT



1/ : include the negotiation for external financial arangement of the project, establishment of project organization and recruitment of consulting firm.

(5) Immediately after the commencement of the civil works for the main facilities, the construction of agricultural development center shall be started for the completion of the project within five years so that extension and training of the modernized farming techniques to the farmers may be given adequately.

C. Operation and Maintenance

1. Executing Agency and Organization

The entire Project works, upon completion of the Project, will be turned over to the NIA Regional Office No.VII, and the responsibility of operation and maintenance of all irrigation and drainage facilities will fall under the Wahig-Pamacsalan River Irrigation System Office (W-PRISO) to be newly organized, as shown in Figure 5-3.

The headquarters staff under the irrigation superindentent would consist of four supporting sections; Operation and Maintenance Section, Engineering Section, Agricultural Section and Administrative Section. The Operation Section would be responsible for day-to-day operations of the system including water scheduling, and maintenance section would handle the equipment and maintenance activities of the Project. The Engineering section would be responsible for the designs, estimates and execution of minor works and on-farm facilities for the purpose of maintenance of facilities. The Agricultural Section would be responsible for the agricultural development center, introducing new water management techniques and farming methods as well as ensuring that necessary agricultural supporting services are established in the area, and the Administration Section would handle the personnel and records management, accounting and other services.

For operation and maintenance purposes, the Project Area which would serves a total area of 5,320 ha would be divided into two irrigation areas, Upper and Lower areas, based upon the topography.

The Lower area covering about 4,800 ha would be further subdivided into two divisions. About 2,500 ha served by one operation division would be controlled by a supervisor and would be subdivided into about 500 ha units. Each unit will be managed under a Water Management Technologist (WMT). A ditch tender would be employed for about three or four units of about 25 ha each, one rotation block. Each WMT, therefore, would be responsible for about five units of the ditch tender.

2. Operation and Maintenance of Facilities

Operation and maintenance of the facilities will be performed by the Irrigators' Association under the jurisdiction of the W-PRISO. On the other hand, the operation and maintenance of the facilities for hydro-power will be undertaken by the NPC. The proposed organization chart for operation and maintenance is shown in Figure 5-3.

The communication among the NIA Regional No.7 Office, the W-PRIS Office and the Operation Offices at Pamacsalan dam site and Malinao diversion dam site would be made by wireless telephone, and also the communication among the W-PRIS Office and each Division Office by the radio transceiver.

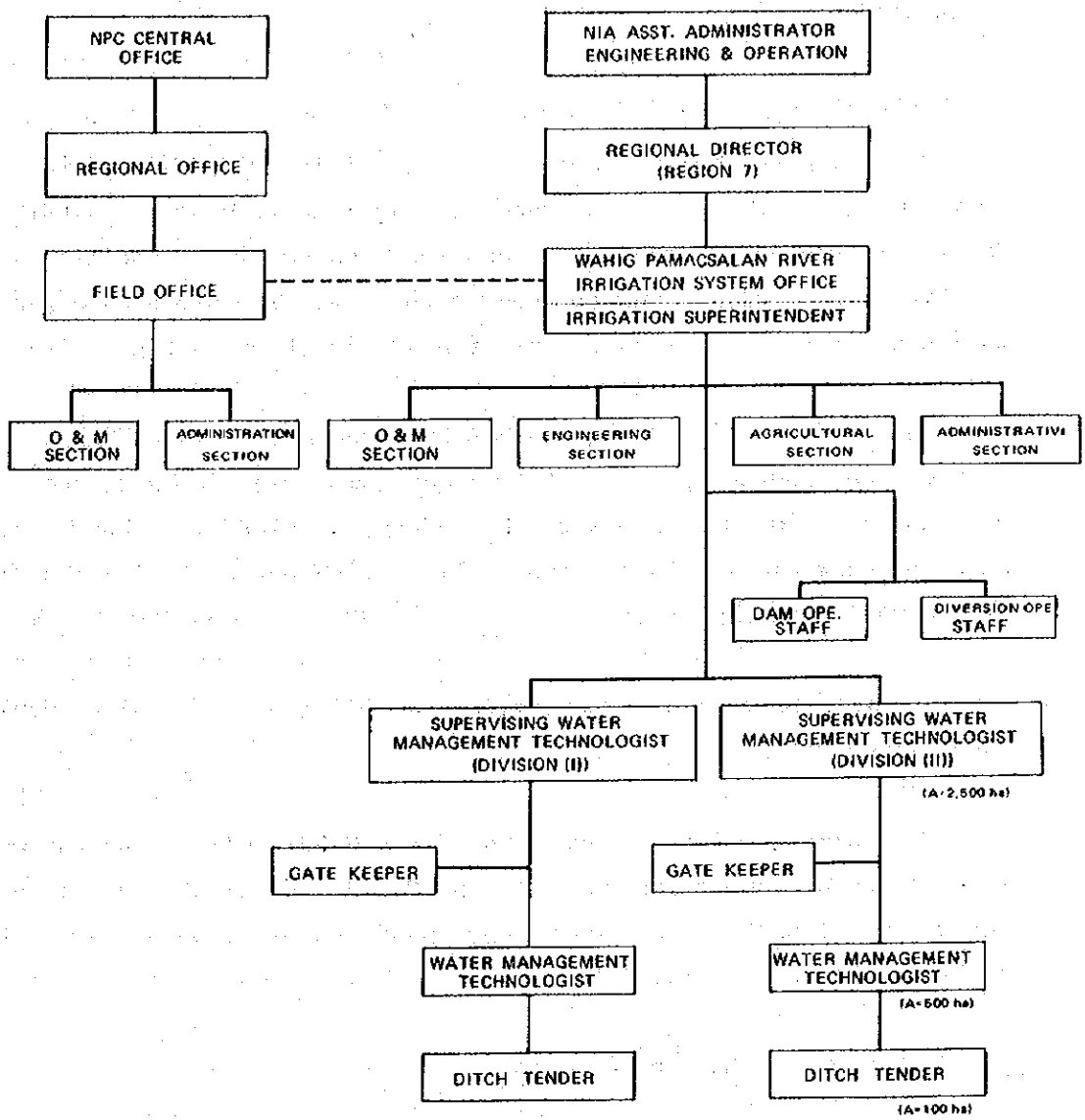
The transportation for operation and maintenance services would be performed by motorcycle.

The communication systems between the W-PRIS Office and the Operation Office at Pamacsalan dam site and Malinao diversion dam site for the water release and emergency correspondence of flood discharge from spillway are to be established.

3. Operation and Maintenance Cost

The operation and maintenance costs for irrigation and other facilities are summarized as follows;

FIGURE 5-3. ORGANIZATION CHART FOR OPERATION AND MAINTENANCE



Annual Operation and Maintenance Cost

Description	O & M Cost ($ '000)	($/ha)	Allocated ($/ha)
I. Irrigation			
a) Salary and Wages	118.9	22.3	21.9
b) Equipment Operations	87.6	16.5	16.4
c) Materials and Supplies	80.1	15.1	15.1
d) Administration & General Expenditure	35.7	6.7	6.6
Sub-total	322.3	60.6	60.0
II. Hydro-power			
a) Salary and wages	9.2 per/annum		
b) Power plant	44.1		
c) Dam and diversion allocated	3.3		
Sub-total	56.6		

Note: Details are given in Appendix 5C-1

D. Consulting Services

The Consultant's services include the implementation of final design and supervision of the Project.

The Consultant's services are divided into the following three phases:

(1) The final detailed design of the Project as well as the preparation of tender document. It will cover 43 month periods starting from June 1979. Highly qualified experts will be engaged, including irrigation engineer, engineering geologist, soil mechanical engineer, hydrogist, design engineer and economist.

(2) Construction supervision and training of local counterpart personnel in all phases of the Project activities. The service period would extend over 61 months from February

1981 to February 1985. The required experts would be project engineers and engineering geologist.

(3) A plan of agri-institutional establishment covering all agricultural institutional development program and training. It would cover 35 months. Highly qualified experts will also be engaged, including agronomist, agri-institutional expert and water and farm management expert.

The Terms of Reference for the Consultant's Services and the Proposed schedule for the Consultant's services are given in Appendix 5D-1.