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RECOMMENDATION ON THE IMPROVEMENT OF THE BARIT RIVER IRRIGATION SYSTEM

BICOL RIVER BASIN
PHILIPPINES

VOLUME II

SUMMARY REPORT

Final Report Submitted to the
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
In Partial Fulfillment of
CONTRACT NO. AID/EA-C-1099

Submitted by
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January 1977

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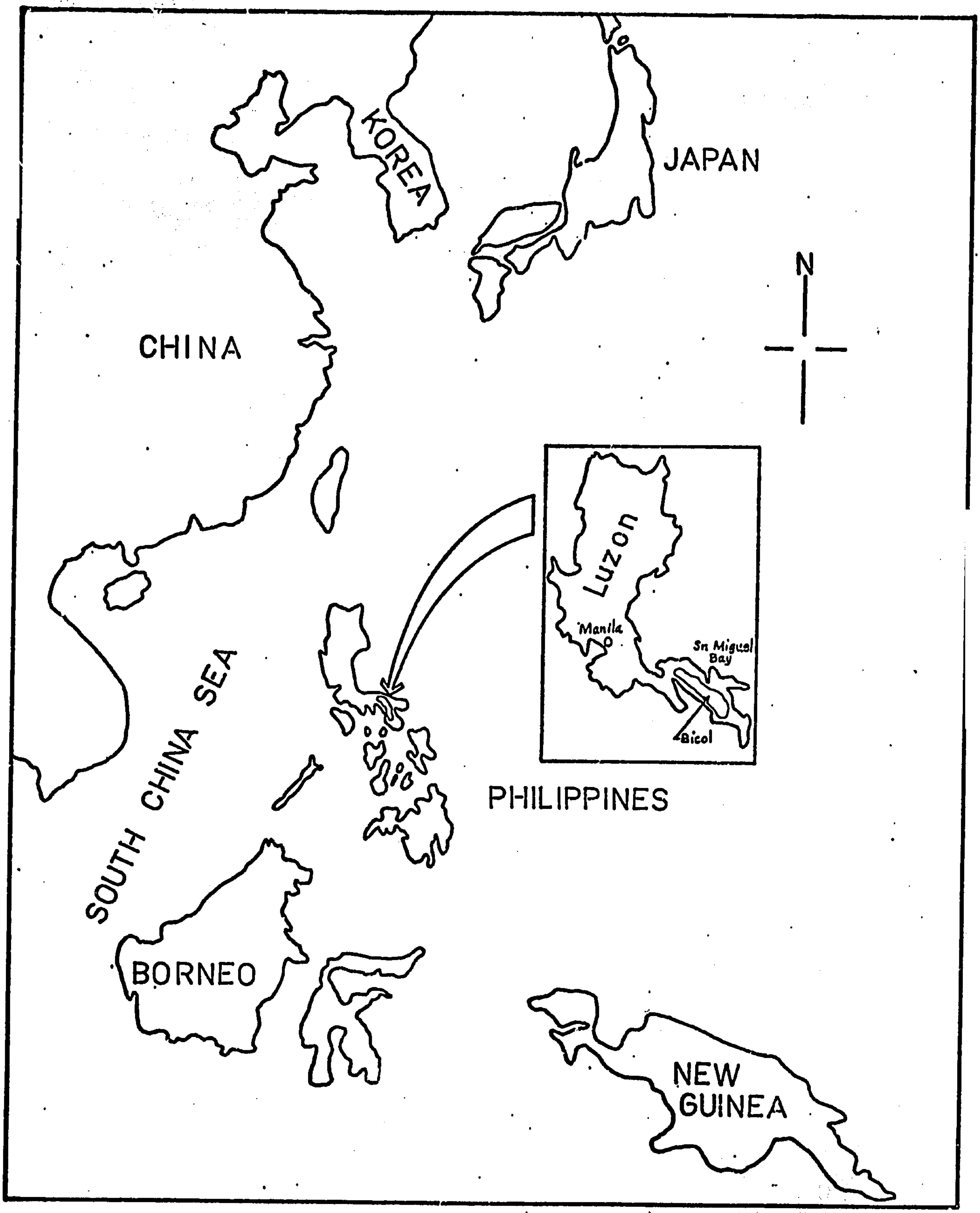
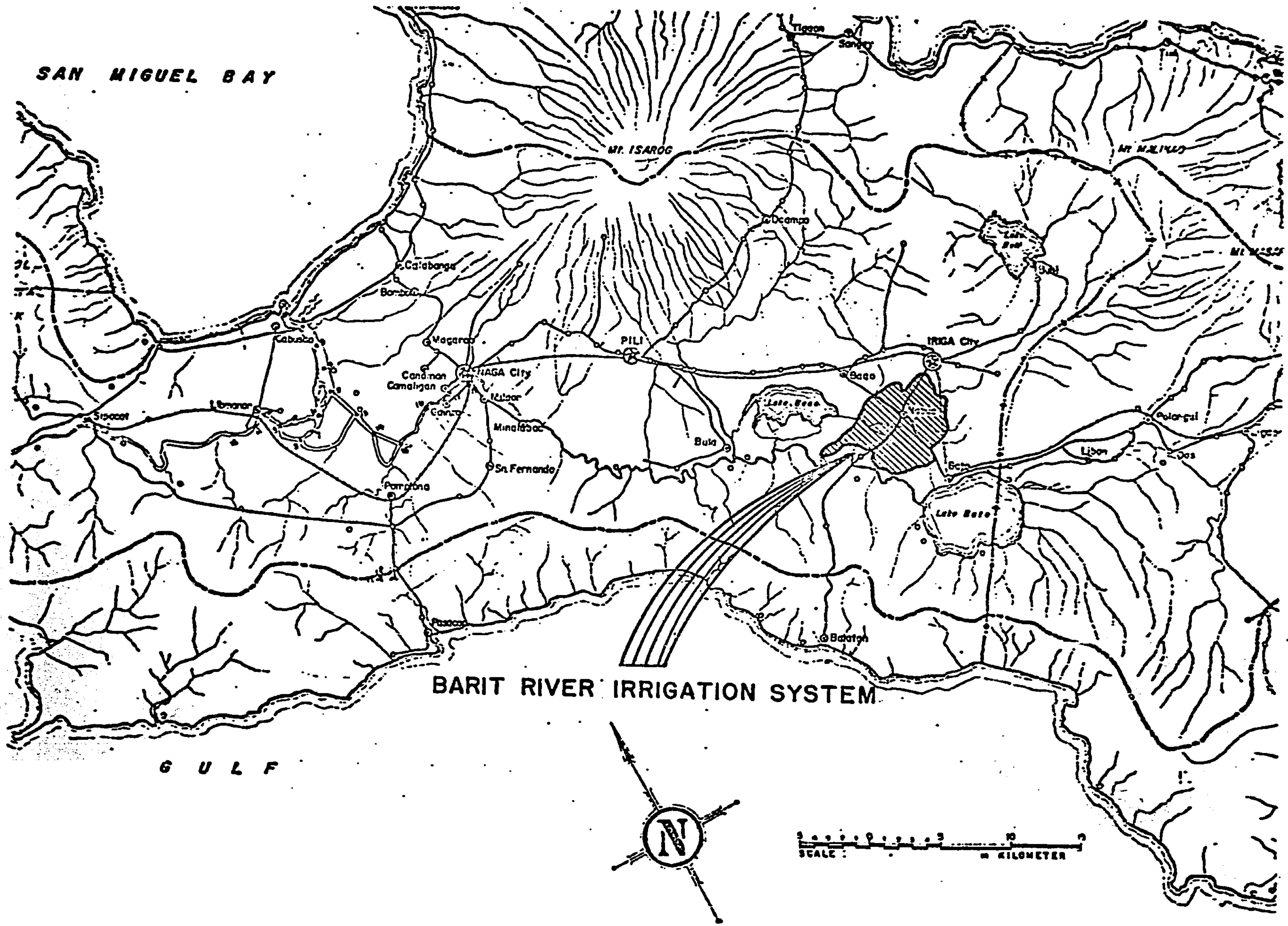


Location map



General location of the Barit River Irrigation System.

CHAPTER I. FORWARD

The primary objective of this research and development project is development of irrigated rice production system design procedures for the project area. The proposed improvements on the irrigation and drainage system, and production schedule must take maximum advantage of the existing system physical facilities. This means the proposed enlargement of primary water conveyance systems must be kept to a minimum. It is expected that the procedures developed will be applicable to similar projects within the Bicol River Basin. The project is also expected to establish terminal water distribution systems and management strategies that are uniquely suited for the Bicol River Basin. Furthermore, maximum utilization of available labor is required to reduce the severe unemployment and underemployment problems currently existing in the Basin area.

The records show that during the past 90 years, the Bicol River Basin Area experienced an average of three tropical cyclones per year. To minimize wind and flood damages, the University of Hawaii research group has developed an interesting approach to crop scheduling and an innovative procedure in drainage system design.

The success of an agricultural development project does not only depend on the narrowly defined economic feasibility. An economically feasible and physically efficient system may be difficult to implement and manage due to the lack of suitable socio-infrastructures that are required for the management and operation of the terminal water distribution and crop production systems. For this reason, the proposed design procedure has taken a systematic approach that allowed careful consideration of the following input variables: irrigation and drainage, on-farm water distribution and management, labor availability and mechanization, farmer organization, in-field transportation, and agricultural inputs. The resultant planning procedure will allow the Bicol River Basin Development Program office to determine the optimal combination of these input variables, leading to suitable agricultural production system designs emphasizing irrigated rice production in the Basin Area.

Briefly, new formulae were developed that reduce peak irrigation water demand in the primary system by up to 30%. A simplified water management scheme has been developed, recognizing the traditional role of the National Irrigation Administration, which allows gradual development of farmer responsibility in terminal water distribution. A basic modification of the rotational irrigation system is established to meet the socio-constraints in the Bicol River Basin. An optimal cropping schedule that minimizes wind and typhoon damages, but takes advantage of peak solar radiation, has been developed. Considering risk factors, there is reason to believe that the proposed two-rice-crops schedule will out-produce the 2½-rice-crops schedule in the long run. The proposed schedule will not demand mechanization within the near future, thereby allowing the gradual development of the rural area before mechanization is required to meet the production goals. An innovative approach to paddy rice drainage has taken into consideration the ability of the rice plant to tolerate temporary submergence. Computer programs have been developed to assist the planning process. Detailed water and labor management requirements have also been developed for the BRIS project area.

Excellent and close working relationships between the University of Hawaii, BRBDPO, the Irrigation Planning Team and the East-West Center Food Institute, has contributed immeasurably to the success of this research and development project.

CHAPTER II. SUMMARY AND CONCLUSION

Section 2.1 The Project

The Barit River Irrigation System (BRIS) is situated around the municipality of Nabua. It includes all the barrios of Nabua and includes some barrios of the Baao municipality and Iriga City, all within the province of Camarines Sur (Figure 2.1). Nabua is approximately 495 kilometers southeast of Manila by road and 43 km south of Naga City, the capital of Camarines Sur.

The majority of the BRIS lies in the flood plain of the Bicol River and its tributaries, the Barit and Waras Rivers. About 90% of the cultivated area within BRIS is devoted to rice production. The project area itself covers slightly over 2800 rice producing hectares. The temperature in the project area ranges from 24-28°C. Relative humidity ranges from 80 to 90 percent. The average rainfall is about 2700 mm and average evaporation loss in a wet paddy is about 1670 mm. The mean solar radiation has two peaks - the first occurs in March-April and the second occurs in November.

The Bicol River Basin area experiences, on the average, three tropical cyclones per year, with one of these three cyclones likely to cause severe damage to crops. Fifty-eight percent of the damaging cyclones occur during the months of October, November and December, and 25% occur during May, June and July. Because of these reoccurring typhoons, drainage and flood control are important considerations in project planning.

The present irrigation system gets its water supply from the Barit River. Analysis of the low streamflow data indicates the water supply may be insufficient during the dry season for four out of every five years.

The Comprehensive Water Resources Study commissioned by the BRBDP reported the average Palay yield for the municipality of Nabua is only 48 cavans per hectare in the wet season, and 54 cavans per hectare in the dry season against a potential of 100 cavans.

The median annual family income in the project area was ₱1,874 in 1971 which was one-third of the metropolitan Manila level. The median income increased to ₱2,172 in 1974 for an annual improvement of 5%, a rate easily negated by annual inflation ranging from 15-25%. The income distribution in the project area follows the pattern for the Bicol River Basin. Approximately 10% of the Basin ouseholds account for a little less than 43% of the entire area income, while the remaining 90% of the population received the remaining 57% of the area's income. Dividing the population into two halves, the richer 50% of the population receives about 87% of the total area income.

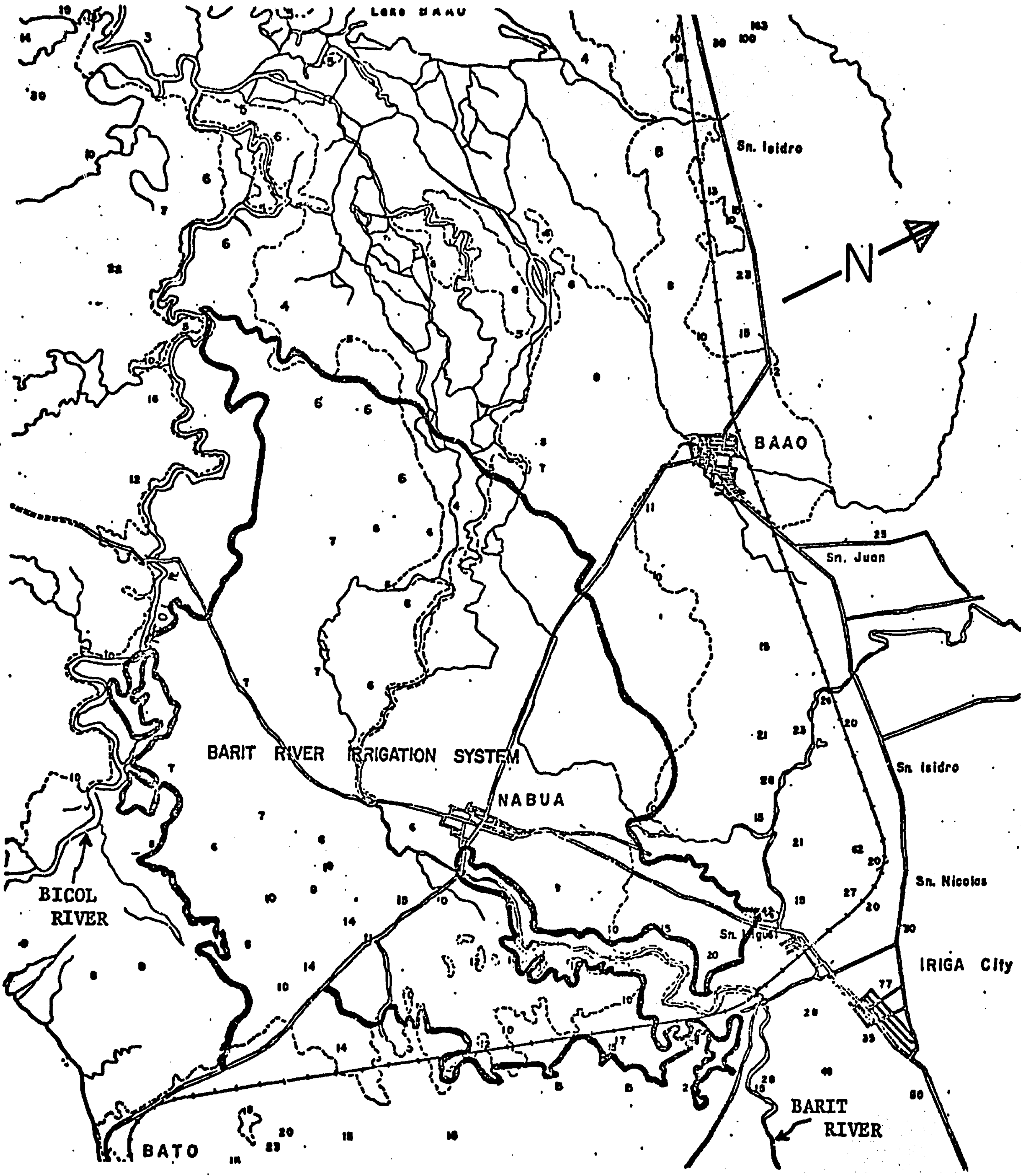


FIGURE 2.1 LOCATION OF THE BARIT RIVER IRRIGATION SYSTEM

The UN-NEC study in 1967 categorized the Bicol River Basin area as a downward transitional area. It is one area in the Philippines experiencing population out-migration caused by the lack of employment opportunities in the Basin Area. Studies conducted in 1974 showed an unemployment rate of 7.7%. In addition, 20.7% of the active labor force is considered to be underemployed. In the Bicol River Basin Area each employed person supports, on the average, 7.38 persons.

To develop the Bicol River Basin, the Bicol River Basin Development Program Office has been created pursuant to PD96. The developmental program is under the direct supervision of the Cabinet Coordinating Committee on Integrated Rural Development Project (CCC-IRDP) of the National Economic and Development Authority (NEDA) through the Cabinet Coordinator, Secretary of Public Works, Transportation and Communication.

The program office of the BRBDP is located in Camarines Sur and is headed by a Program Director who is responsible for the coordination of inter-agency planning and management of basic projects. The program office is also responsible for the identification of projects, studying the feasibility of identified projects, and the generation of capital funds needed for the implementation of projects.

To provide planning and management policy guidelines for the day-to-day operation of the program office, and to serve as the forum to resolve inter-agency coordination problems, the Bicol River Basin Coordinating Committee (BRBCC) was established. It is composed of regional directors of involved agencies and the Governors of the Provinces of Albay and Camarines Sur.

The Basin Area of approximately 312,000 ha, including a watershed area of approximately 185,000 ha, has been divided into ten integrated area development projects (IAD). They are:

I. The Libmanan-Cabusao IAD Project (FY '75 AID Loan).

II. Pili IAD Project

(a) Bula Project (proposed AID loan, FY '77)

(b) Other Pili projects

III. Rinconada IAD Project

(a) Rinconada IAD Project (proposed AID loan, FY '77)

(b) Proposed Lake Bato-Pantao Bay diversion channel, Lake Buhi, Lake Baao drainage and flood control project (other donor assistance)

IV. Naga-Calabanga IAD Project

V. Baliwag-St. Vicente IAD Project (other donor assistance)

VI. Quinali IAD Project (proposed AID loan FY '79)

VII. Agro-Industrial Development Area

VIII. Sipocot-Del Gallego IAD Project

IX. Partido IAD Project

X. Caramoan IAD Project

The BRIS project is within the Rinconada IAD project area. It is the intention of the Agency for International Development to use the Barit River Irrigation System Improvement Project as a pilot project for the design of a comprehensive rice production system. The BRIS is selected because its problems are representatives of similar problems commonly found within the Bicol River Basin. Secondly, since the developmental planning for the Libmanan-Cabusao IAD project has closely followed traditional procedures, the BRIS project represents the first attempt of the USAID and BRBDP to develop innovative planning procedures which can be applied to subsequent Basin projects.

The research team has been asked to look at a number of input variables and to identify constraints, both physical and social, to the planning process. The development of improved planning and design procedures for efficient irrigated rice production systems based on a water management strategy compatible with the existing social constraints in the Basin was also requested.

In short, this project is an attempt to integrate the physical and environmental constraints with the social constraints and to apply these constraints to the planning of an irrigated rice production system within the Bicol River Basin project area.

Section 2.2 Objectives

The ultimate goal of the Bicol River Basin Development Program is to improve the quality of life of the people. The intermediate goals are to: 1) increase per capita income; 2) achieve an equitable distribution of wealth; and 3) to attempt self-sufficiency in food.

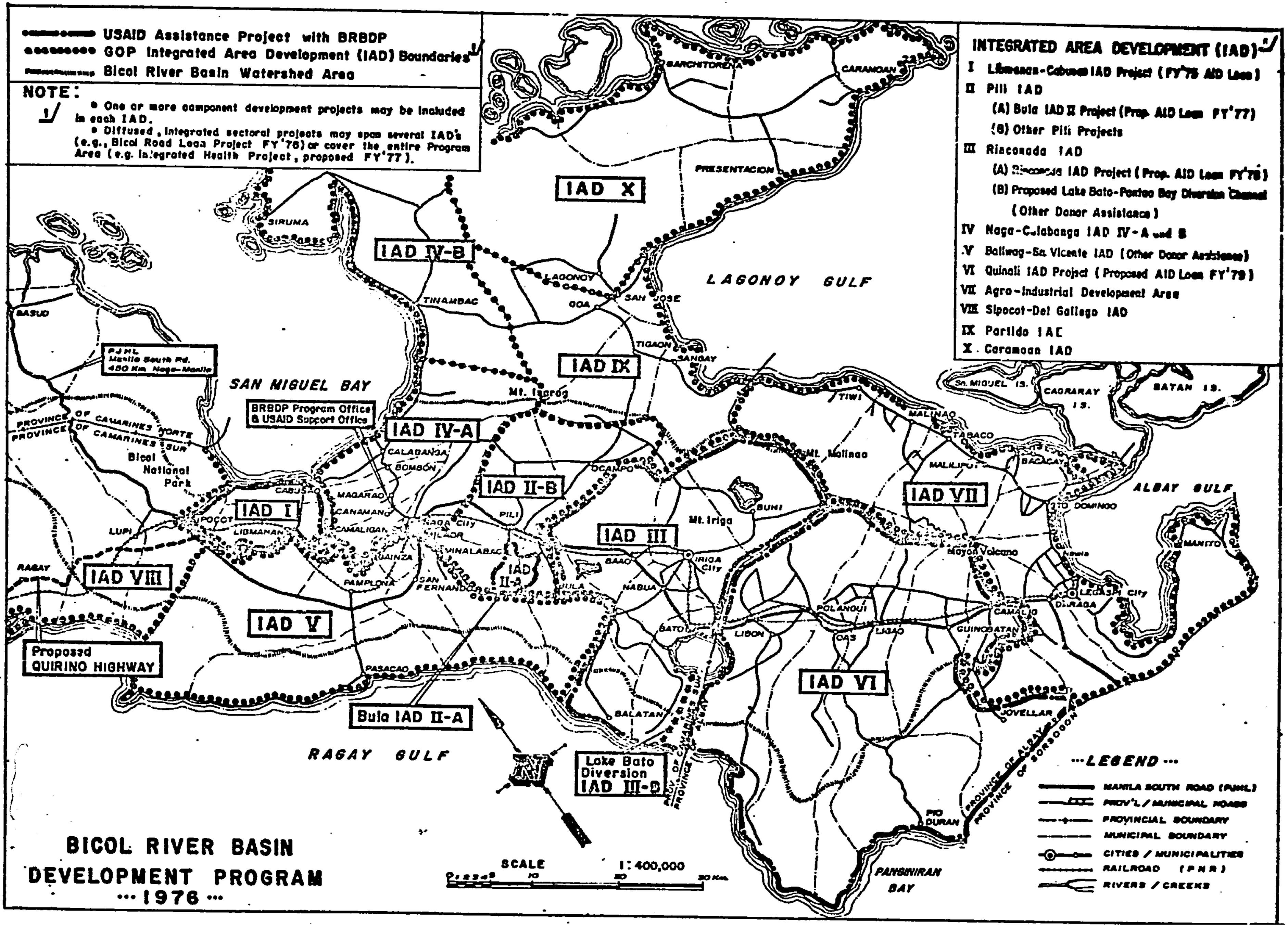
The objectives of the Barit River Irrigation System are:

1. The development of a planning procedure having basin-wide application, so that physically efficient irrigation and drainage systems can be established upon a foundation of socially acceptable water management infrastructural requirements.

2. To develop the first installment of expertise required to apply the developed planning procedure to other Basin projects.

Section 2.3 Strategies

Successful planning of an irrigated rice production project cannot be judged on some narrowly defined economic feasibility. Water management, especially in-field water distribution management, is obviously



USAID Assistance Project with BRBDP
GOP Integrated Area Development (IAD) Boundaries 1/
Bicol River Basin Watershed Area
NOTE:
1/ • One or more component development projects may be included in each IAD.
• Diffused, integrated sectoral projects may span several IAD's (e.g., Bicol Road Loan Project FY'76) or cover the entire Program Area (e.g. Integrated Health Project, proposed FY'77).
INTEGRATED AREA DEVELOPMENT (IAD) 1/
I Libmanan-Cabusao IAD Project (FY'75 AID Loan)
II Pili IAD
(A) Bula IAD II Project (Prop. AID Loan FY'77)
(B) Other Pili Projects
III Rinconada IAD
(A) Rinconada IAD Project (Prop. AID Loan FY'78)
(B) Proposed Lake Bato-Pantao Bay Diversion Channel
(Other Donor Assistance)
IV Naga-Calabanga IAD IV-A and B
V Baliwag-Sn. Vicente IAD (Other Donor Assistance)
VI Quinali IAD Project (Proposed AID Loan FY'79)
VII Agro-Industrial Development Area
VIII Sipocot-Del Gallego IAD
IX Partido IAD
X Caramoan IAD
IAD X
IAD IV-B
IAD IX
IAD IV-A
IAD II-B
IAD I
IAD III
IAD VII
IAD VIII
IAD II-A
IAD V
IAD VI
Bula IAD II-A
Lake Bato Diversion IAD III-B
PJHL Manila South Rd. 450 Km. Naga-Manila
BRBDP Program Office & USAID Support Office
Proposed QUIRINO HIGHWAY
SAN MIGUEL BAY
LAGONOY GULF
ALBAY GULF
RAGAY GULF
PANGINIRAN BAY
PROVINCE OF CAMARINES NORTE
PROVINCE OF CAMARINES SUR
PROVINCE OF ALBAY
PROVINCE OF SORSOGON
Bicol National Park
GARCHITORENA
CARAMOAN
PRESENTACION
SIRUMA
TINAMBAC
LAGONOY
GOA
SAN JOSE
TIGAON
SANGAY
Mt. Isarog
CALABANGA
BOMBON
MAGARAO
CANAMAN
CAMALIGAN
NAGA City
MILAOR
CABUSAO
POCOT
LIBMANAN
LUPI
RAGAY
BASUD
GAINZA
PAMPLONA
SAN FERNANDO
MINALABAC
PILI
OCAMPO
Mt. Iriga
BUHI
BAAO
IRIGA City
NABUA
BULA
BATO
BALATAN
LIBON
POLANGUI
OAS
LIGAO
GUINOBATAN
CAMALIG
DARAGA
LEGASPI City
MANITO
STO DOMINGO
BACACAY
MALILIPOT
TABACO
MALINAO
Mt. Malinao
TIWI
Mayon Volcano
Sn. MIGUEL IS.
CAGRARAY IS.
BATAN IS.
JOVELLAR
PIO DURAN
PASACAO
SCALE 1:400,000
BICOL RIVER BASIN DEVELOPMENT PROGRAM
1976
LEGEND
MANILA SOUTH ROAD (PJHL)
PROV'L / MUNICIPAL ROADS
PROVINCIAL BOUNDARY
MUNICIPAL BOUNDARY
CITIES / MUNICIPALITIES
RAILROAD (PNR)
RIVERS / CREEKS

important to the production of rice. Therefore, the development of a socially acceptable water management scheme may be one of the keys to the successful planning and implementation of an irrigated rice production system.

In the Philippines, the National Irrigation Administration has traditionally been given the responsibility for the managment of irrigation systems. It is well recognized, however, that it is desirable to have the farmers, who are the beneficiaries of developmental projects, take an active role in the management of the irrigation system. The reasons are simple; modern irrigated rice production systems require extensive in-field water distribution systems in order to efficiently utilize and distribute the available water uniformly. It would be extremely difficult for any governmental agency to maintain and operate such terminal water distribution systems without the active participation of farmers. Therefore, it is important to develop a water management scheme that will allow NIA its traditional responsibility in the maintenance of the primary water conveyance systems, and at the same time allow farmers to gradually assume increasing responsibilities in the operation and maintenance of the irrigation system.

The peak irrigation water demand of an irrigated rice production system directly relates to the cost of the system. The capacity of the primary conveyance system is designed to accommodate the peak demand. In the traditional Taiwanese procedure, the peak demand will occur only during one or two days in each rice crop cycle. Furthermore, in most tropical areas the peak irrigation water demand may frequently exceed the availability when the irrigation water supply source is derived from either stream flow or ground water sources. For these reasons, the traditional design formulae developed in Japan and Taiwan need to be improved in order to reduce the peak water demand and increase the water conveyance system efficiency.

The above clearly indicates the need to develop an irrigation system, which is rotational in nature, but does not require the highly organized farmer irrigation organization. A consistent rotational schedule would be desirable in order to reduce management problems. The formulation of the irrigation schedule must also allow efficient utilization of available labor, which means the peak labor requirement during transplanting and harvesting of rice must be reduced for a project area. The development of the necessary formulae and design procedures for the desired irrigation system has been the first and foremost research task faced by the University of Hawaii research team.

The commonly used procedure for highway and urban drainage designs involve using peak discharge as the design capacity. This procedure is not suitable to the paddy rice production system drainage design since rice plants at different growth stages can endure limited periods of submergence without substantial damage. Therefore, the concept of peak discharge design must give way to an innovative procedure that is based upon the concept of controlling damage and reducing risk. The second research task, therefore, is to develop a procedure for drainage system design based on the duration and depth of rice plant submergence allowed at different stages of growth.

The Bicol River Basin area, with its tropic climate, can support agricultural activities, including irrigated rice production, on a year round basis. On the other hand, the statistical pattern of tropical cyclones and damaging typhoons raises serious questions about the economic advantages of a continuous cropping pattern. The development of an optimal cropping pattern under the constraints imposed by the climate conditions of the River Basin is therefore important.

Section 2.4 Project Costs

The recommended improvements to the BRIS are contained in five components - three capital investment components and two socio-infrastructural components. The capital investment components include rehabilitation and construction of new facilities within the BRIS, enlargement of the reservoir, and dredging to improve external drainage. The socio-infrastructural components include organization and training of water users and tenurial development.

The five project components will require a total investment of ₱21,947,000 within a 5-year time frame. Components 1, 2, and 3 will require about ₱20,004,000, and will be completed within three years.

Section 2.5 Implementation

It is expected that the BRBDP will establish an Area Development Team (ADT) in the area which will stimulate and coordinate the joint efforts of the government agencies and local leaders in the area through the area development council (ADC).

Construction of irrigation and drainage facilities (Components 1, 2, and 3) will be completed in phases during the first three years. Simultaneously, farm level training and the tenural development program will be inaugurated. A short-term consultant, who is experienced and familiar with the development and management of water user organizations will be recruited to examine and recommend revisions to the proposed plan for creating water user associations in the terminal distribution units and on a system-wide basis. The currently existing plan anticipates that NIA will test run and operate the system in the fourth year, and responsibility for operating and maintaining the system will be delegated to a system-wide water users association in the fifth year.

Section 2.6 Benefits and Beneficiaries

By the fourth year, it is expected that all 2,809 hectares will have a production capability which corresponds to the irrigated 1R land as described in the economic land classification study conducted in 1975. Currently, 1,789 hectares are classified as irrigated 1R, 768 hectares are classified as irrigated 2R, 224 hectares are classified as 3R, and about 30 hectares are classified as 6d. If the project is constructed, the annual net farm income stream of all farmers in the project area is expected to increase from ₱11,030,000 in 1978 to ₱23,859,000 in 2005. If the project is not constructed, the annual net farm income stream is expected to increase to ₱19,652,000 by 2005.

The direct beneficiaries of the project number about 6,297 farm households. In addition to benefits from the irrigation and drainage facilities all households in the project area will have greater access to neighboring barrios and municipalities.

Section 2.7 Economic Evaluation

The project is conceived as an integrated matrix of the five components. After adjusting for probable reductions in project related costs and reductions in annual net farm income streams if the project is not constructed, it is expected that the project will obtain an internal rate of return of more than 22 percent, will have a benefit-cost ratio of more than 1.4 and will have a net present value of more than ₱7,100,000 at an interest rate of 15 percent. See Table 2.1.

Economic evaluation using cost and benefit data which were available obtain an internal rate of return of 11.7 percent and a benefit-cost ratio of 0.794 and a discounted present value of invested capital of ₱4,605,000 at an interest rate of 15 percent. However, it is expected that additional analysis will discover substantial 1) reductions in the cost of constructing the proposed farm roads and farm ditches and 2) increases in the net farm benefits.

Section 2.8 Relationship of this Project to other Projects in the Bicol River Basin

The BRIS is located within the boundaries of the Rinconada IAD. Two components in this project should be considered within the context of their relationship to other development activities being considered in the Rinconada IAD. These are Component 2 (External Drain) and Component 3 (Increase the Storage Capacity of Lake Buhi). In addition, consideration of the external drain should include its impact on downstream areas which will receive runoffs from BRIS and the Rinconada IAD.

Table 2.1 Summary of Indicators of Economic Feasibility of Proposed Improvements to BRIS

Situation[1/]	IRR (Percent)	DPU (Pesos 1,000)	B/CR
Base Case	11.65	-4,605	0.794
If the current NIA improvements are separated	14.59	- .472	0.974
If one-half of the proposed farm ditches already exist	13.04	-2,463	0.878
If the current NIA improvements are separated and one-half of the farm ditches already exist	16.62	1,671	1.104
If some area is rainfed	15.61	826	1.037
If some area is rainfed, if NIA costs are separated, and if one-half of proposed farm ditches already exist	22.2	7,107	1,441

[1/] For details of alternative situations see Chapter 10.

CHAPTER 3. DESCRIPTION OF THE PROJECT AREA

3.1 Location and Area Profile

The Barit River Irrigation System (BRIS) project area of 2,809 hectares is within the Camarines Sur portion of the Bicol River flood plain. It predominantly covers the municipality of Nabua and some portions of Iriga City and Baao. Nabua is about 43 kilometers South of Naga City, the major trading center of the Bicol Region, and approximately 495 kilometers southeast of Manila by road.

The project area is composed of relatively flat agricultural lands which are well suited to lowland rice cultivation. The Barit River which is the main source of irrigation water, supplemented by Waras Creek, cannot meet the water demands of the project area. Furthermore, the limited supply of water is not efficiently and economically distributed due to inadequate irrigation facilities. Moreover, stagnant inundation of paddy fields brought about by the illegal construction of dams and diversion roads by private individuals further aggravate the problem. Thus, about 65 per cent of the total project area is devoted to irrigated rice production during the wet season and about 40 per cent during the dry season. Most of the time, farmers whose farms receive water from the lower half of the lateral experience serious irrigation water insufficiency during the dry periods of the year while others cannot cultivate their fields because of drainage constraints.

Roads are the dominant means of transportation within the project area. Although it is served by eight-kilometers of roads along the main canal, one-kilometer of road along the laterals and sub-laterals, and nine kilometers of barrio and municipal roads, the poor condition of these earth roads greatly hampers the transport of farm produce and supplies.

3.2 Project Beneficiaries

3.2.1 Population In 1975 the population of the project area (see Table 3.1) was 33,583 with a population density of about 12 persons per hectare This is below the regional population density.

The greatest portion of the project area is in Nabua, and its population comprises seventy-four per cent of the total project area population, only twenty-five and one per cent, respectively, comes from the Iriga City and Baao portions.

TABLE 3.1 - Population of the BRIS Area, 1975

Location	Population	Per Cent
Nabua Portion	24,776	74
Iriga City Portion	8,425	25
Baao Portion	382	1
TOTAL	33,583	100

Source: Municipal Secretaries and Iriga City Planning and Development Staff Office.

3.2.2 Farm Tenure Sixty-one per cent of the total number of farmers in the project area are owner-cultivators. Tenant-tillers constitute about thirty-six per cent; lessees, two per cent; and others are unclassified.

TABLE 3.2 - Farm Tenural Situation, BRIS Area, 1975

Tenure	Number	Per Cent
Owner-cultivator	3,844	61.04
Tenant-tiller	2,295	36.44
Leasse	139	2.22
Others	19	0.30
TOTAL	6,297	100.00

Source: BRIS Office of the Irrigation Superintendent

3.2.3 Farm Production Activities Project area residents depend on palay production for their income. Available data on the palay yield in 1974, as noted by the Office of the BRIS Superintendent, show that the average yield per hectare was 77 cavans and 72 cavans during the wet and dry seasons, respectively.* This yield behavior, wherein the dry season yields less than the wet season, is abnormal and points out the existance of farm production constraints, especially irrigation and drainage problems.

3.2.4 Farmers Organizations A Farmer Irrigator's Congress has been organized and it is divided into fifteen districts. However, only two districts, composed of twenty-three compact farms, are presently operational.

*The NIA exempts farmers from payment of water fees for the following reasons: 1) the system cannot supply water, 2) the system cannot assure a continuous supply of water, 3) at least 60% of the farmers crop is destroyed by infestation or pests, 4) the crop is destroyed by a natural calamity such as typhoon or flooding. Fields exempted from payment of water fees are not used in the calculation of the average yield for the system. This tends to make the average yield appear higher than it actually is.

3.3 Physical Environment

3.3.1 Climate

The Barit River Irrigation System (BRIS) project area has a tropical climate with a temperature range of 24-28°C. Its relative humidity varies between 80-90% and it receives about 2700 mm of rainfall and the paddy field loses an average of 1670 mm of moisture annually through evaporation. The mean solar radiation has two peaks, the first occurs in late March and early April and the second, a lesser peak, occurs in November. This general information is shown in Figures 3.1 through 3.5.

Tropical Cyclones:*

The occurrence of tropical cyclones, because of their frequency and ability to cause damage to agricultural production, is of special interest to agricultural production planners.

For the years 1884-1976, approximately 259 tropical cyclones influenced the weather of the Bicol River Basin, average 3 per year. The annual distribution pattern of the cylcones which caused damage to rice crops is of particular importance. A total of 91 damaging cyclones has occurred during this period. Of these damaging cyclones, 58% occurred during the months of October, November and December and 25% occurred during the months of May, June and July. Analysis shows a conditional probability of 0.28 that at least one damaging cyclone will occur in October, November or December given the occurrence of at least one damaging cyclone occurring during the period May, June and July. Probabilities for other events were also calculated.

Table 3.3/ Probability of damaging cyclone occurrence

Event	Probability	Event	Probability
2 cyclones in 1 year	0.22	3 cyclones in 2 years	0.18
3 cyclones in 1 year	0.09	4 cyclones in 2 years	0.13
2 cyclones in 2 years	0.36	5 cyclones in 2 years	0.07

Figure 3.6 shows the tropical cyclone monthly distribution for the Bicol River Basin. Figure 3.7 shows the monthly distribution of damaging cyclones. A list of the cyclone occurrence dates is found in Annex C.

*Tropical Cyclones are classified into three categories:
- Tropical Depression - maximum wind speed up to 61 kph (38 mph).
- Tropical Storm - maximum wind speed from 62 to 117 kph (39-73 mph).
- Typhoon - maximum wind speed exceeds 117 kph (73 mph).

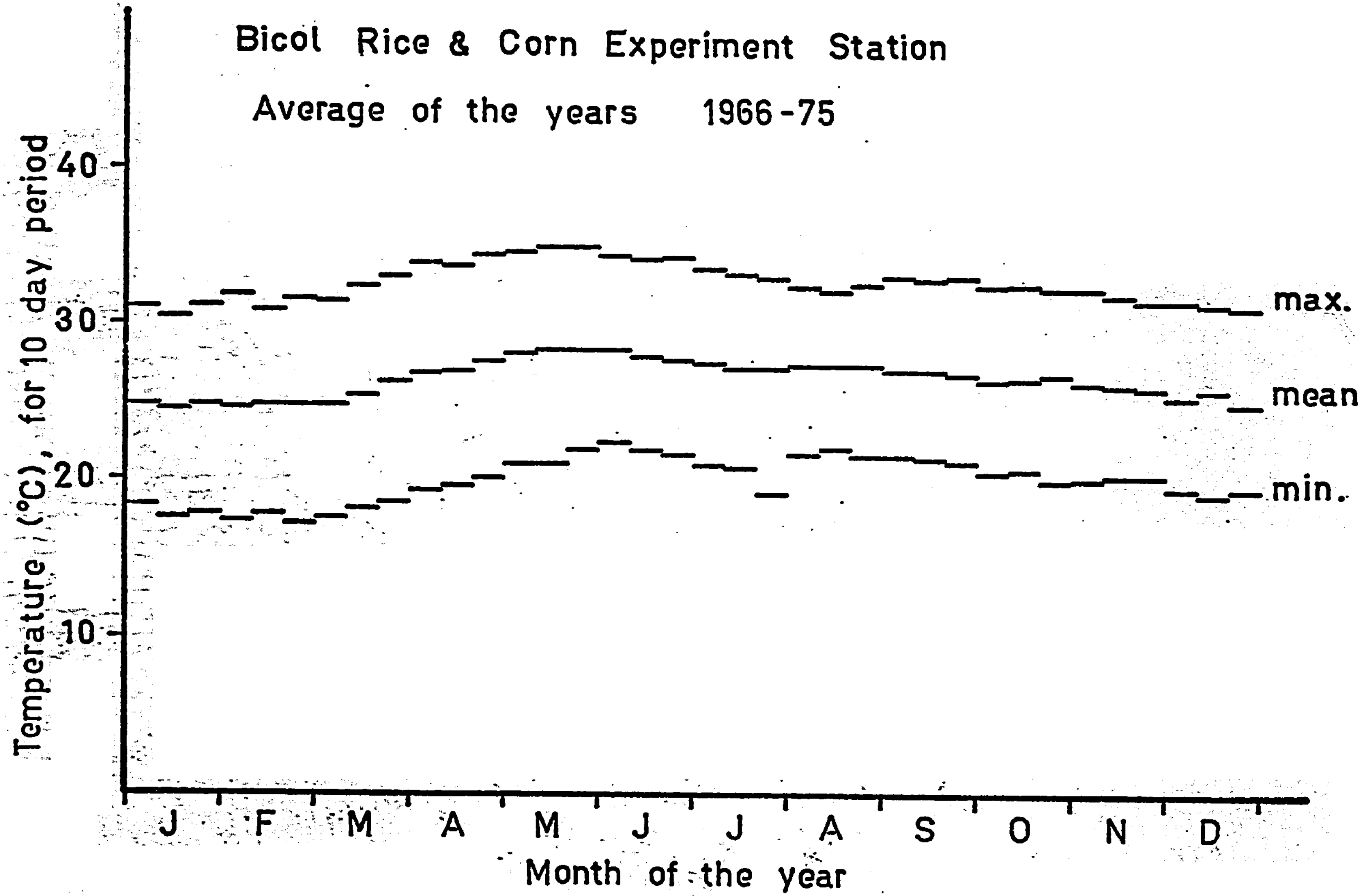


Figure 3.1 Yearly temperature distribution: San Agustin, Pili

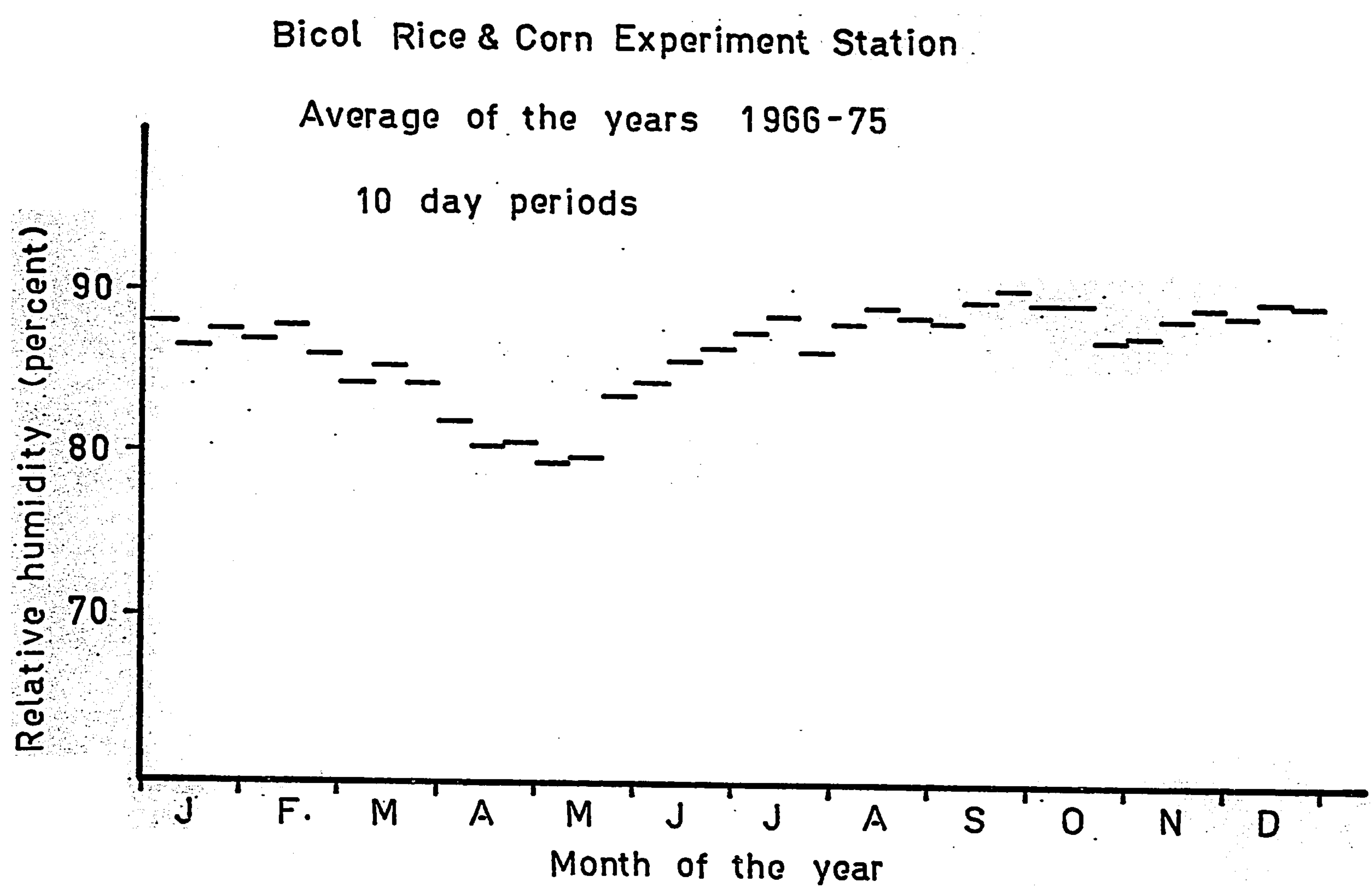


Figure 3.2. Relative humidity distribution: San Agustin, Pili

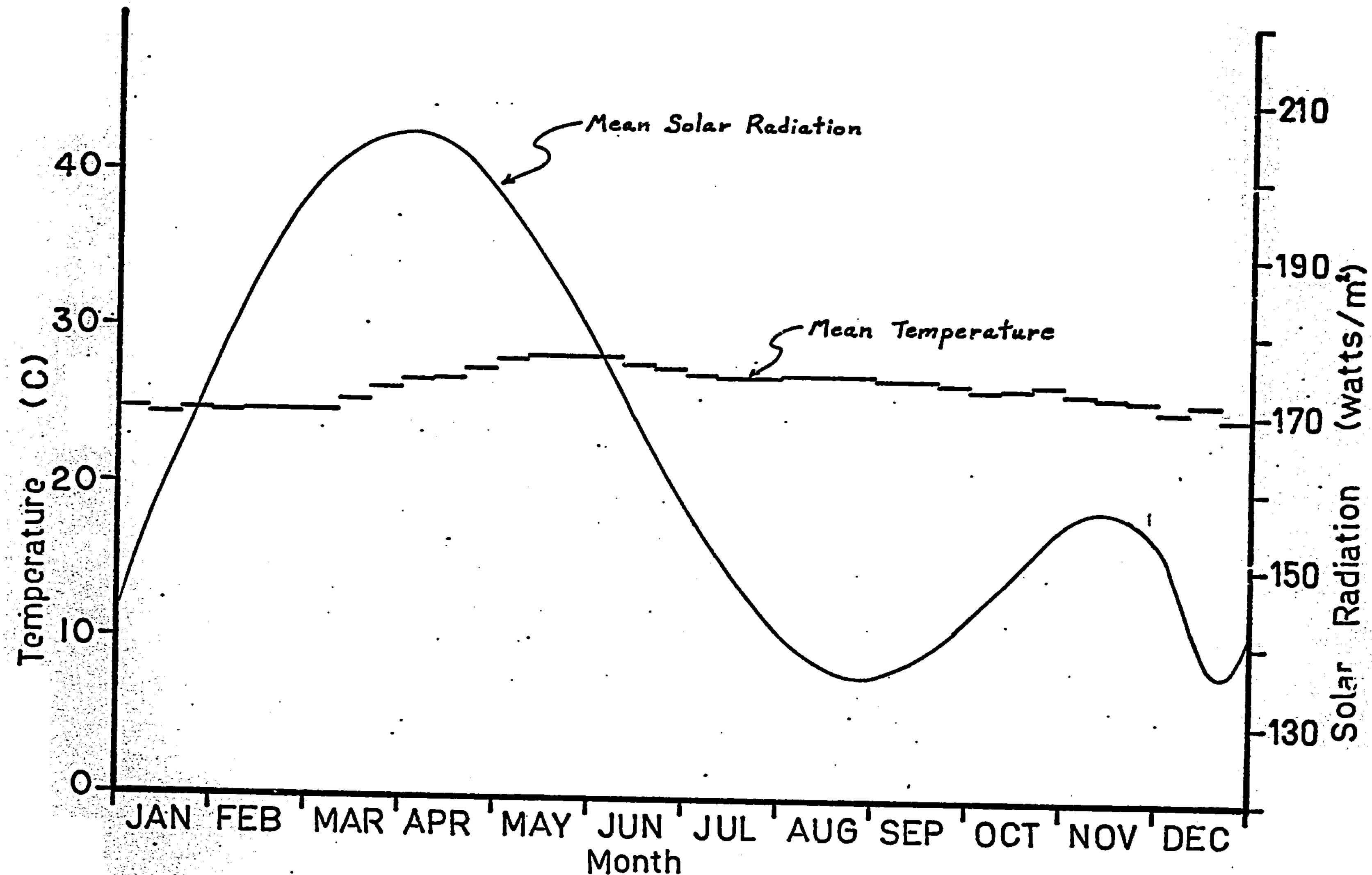


Figure 3.3. Temperature and radiation, San Agustin, Pili

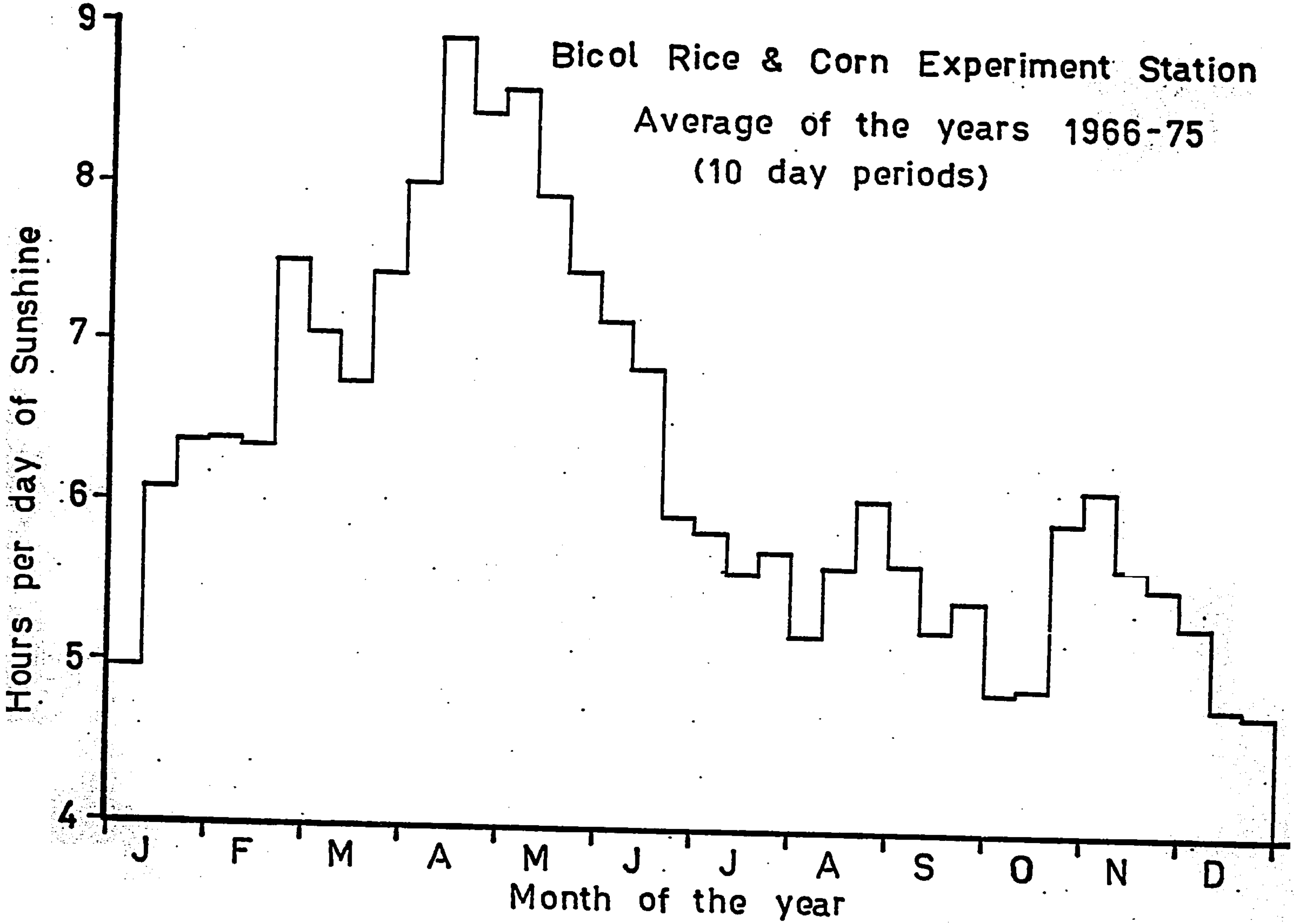


Figure 3.4. Yearly sunshine distribution: San Agustin, Pili

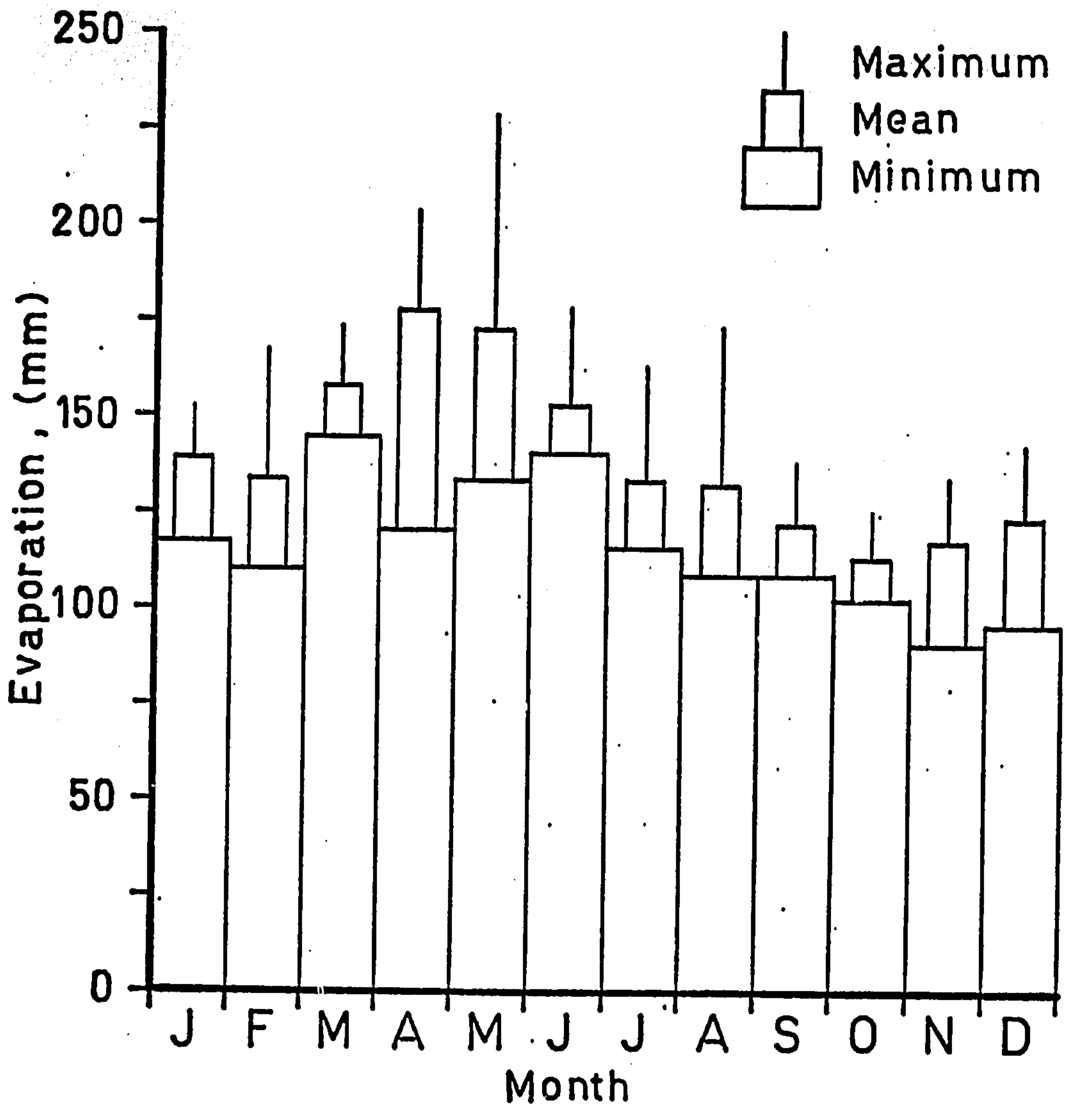


Figure 3.5. Monthly evaporation, Naga City 1957 - 1965

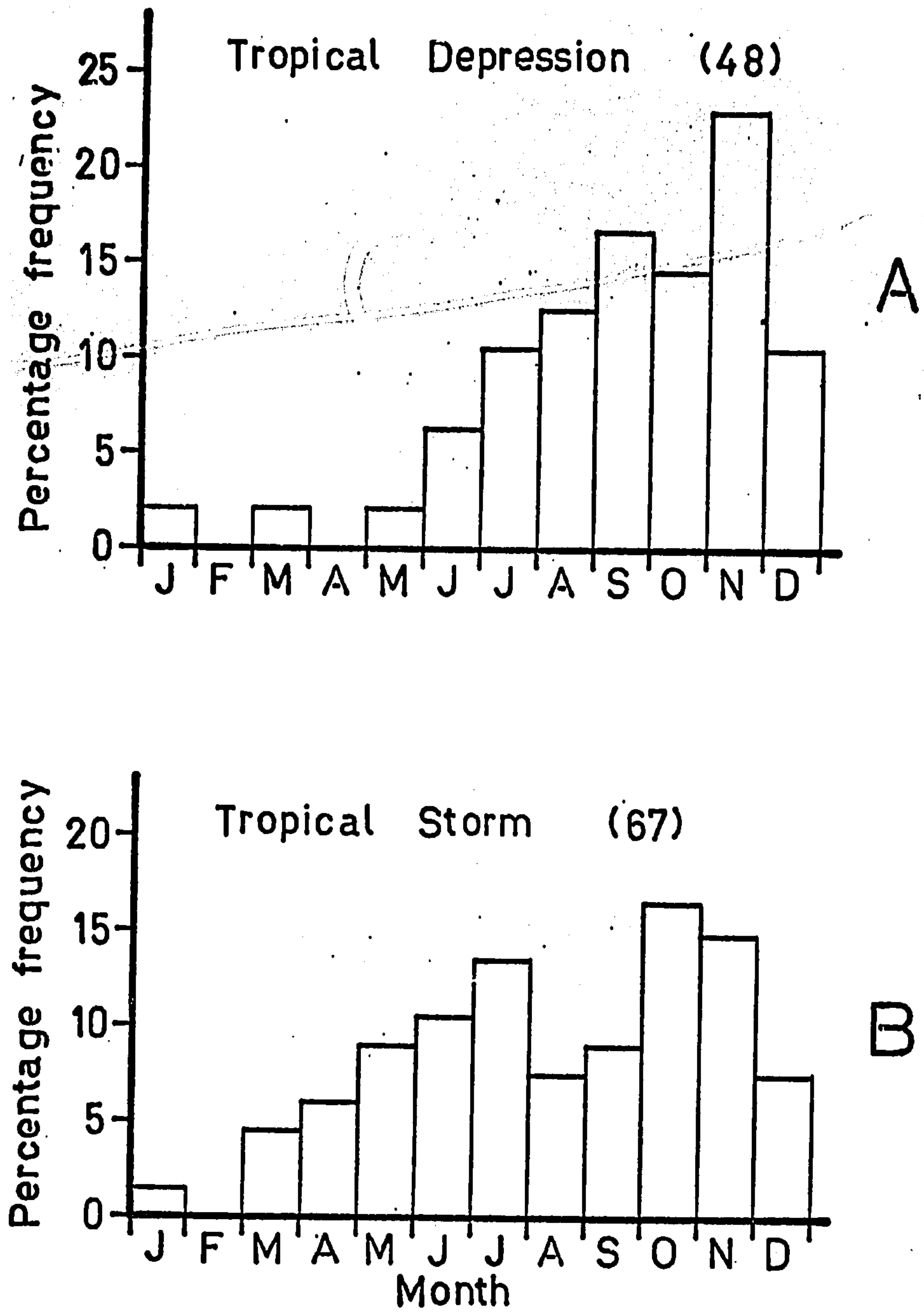
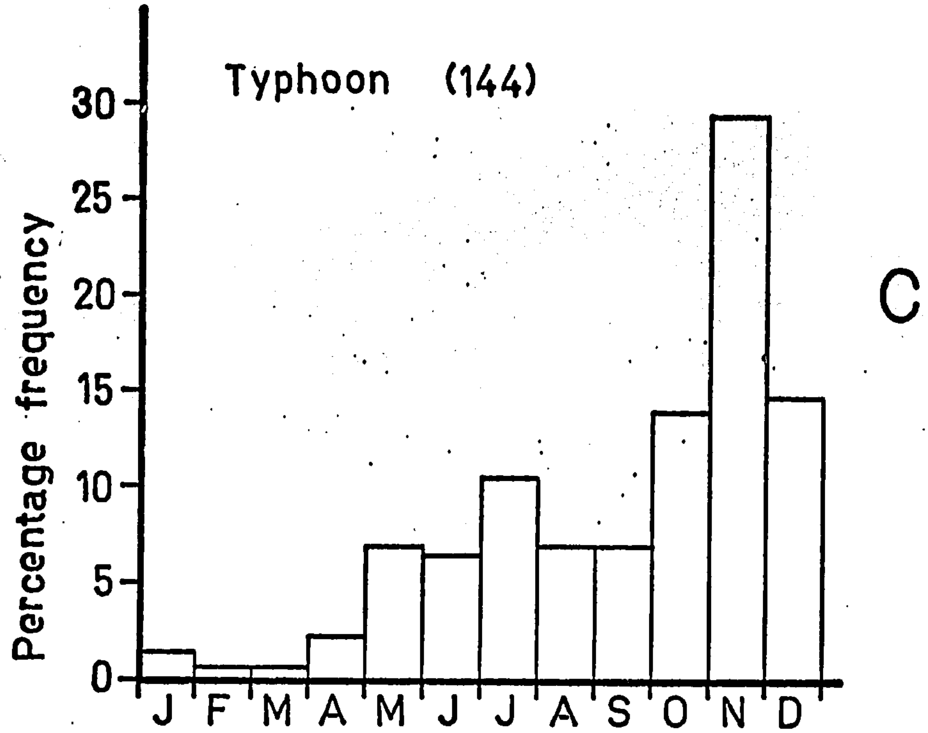


Figure 3.6. Distribution of tropical cyclones effecting the weather of the Bicol River Basin, 1884-1976



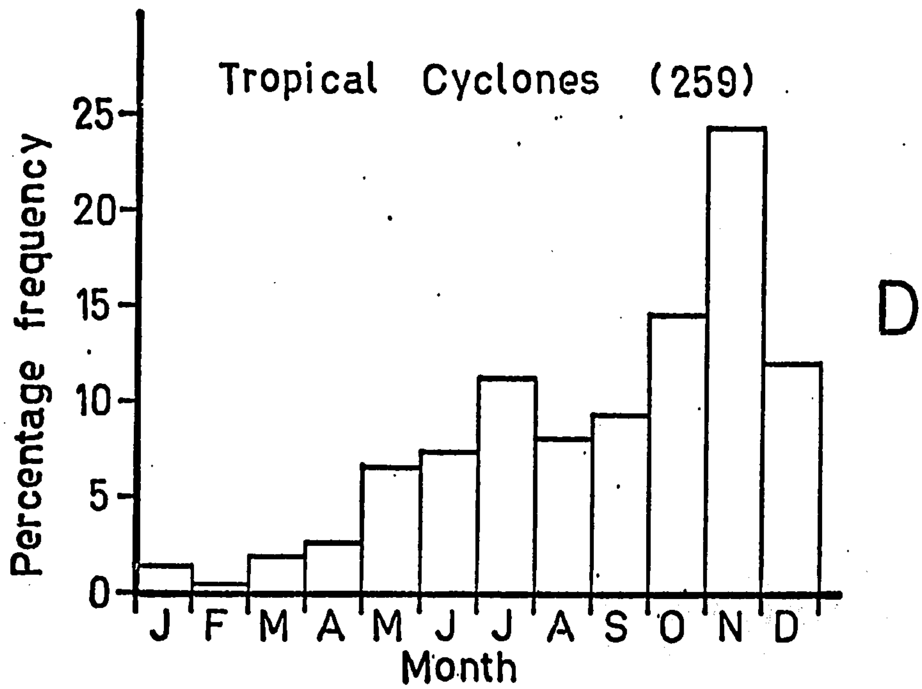


Figure 3.6. (cont.)

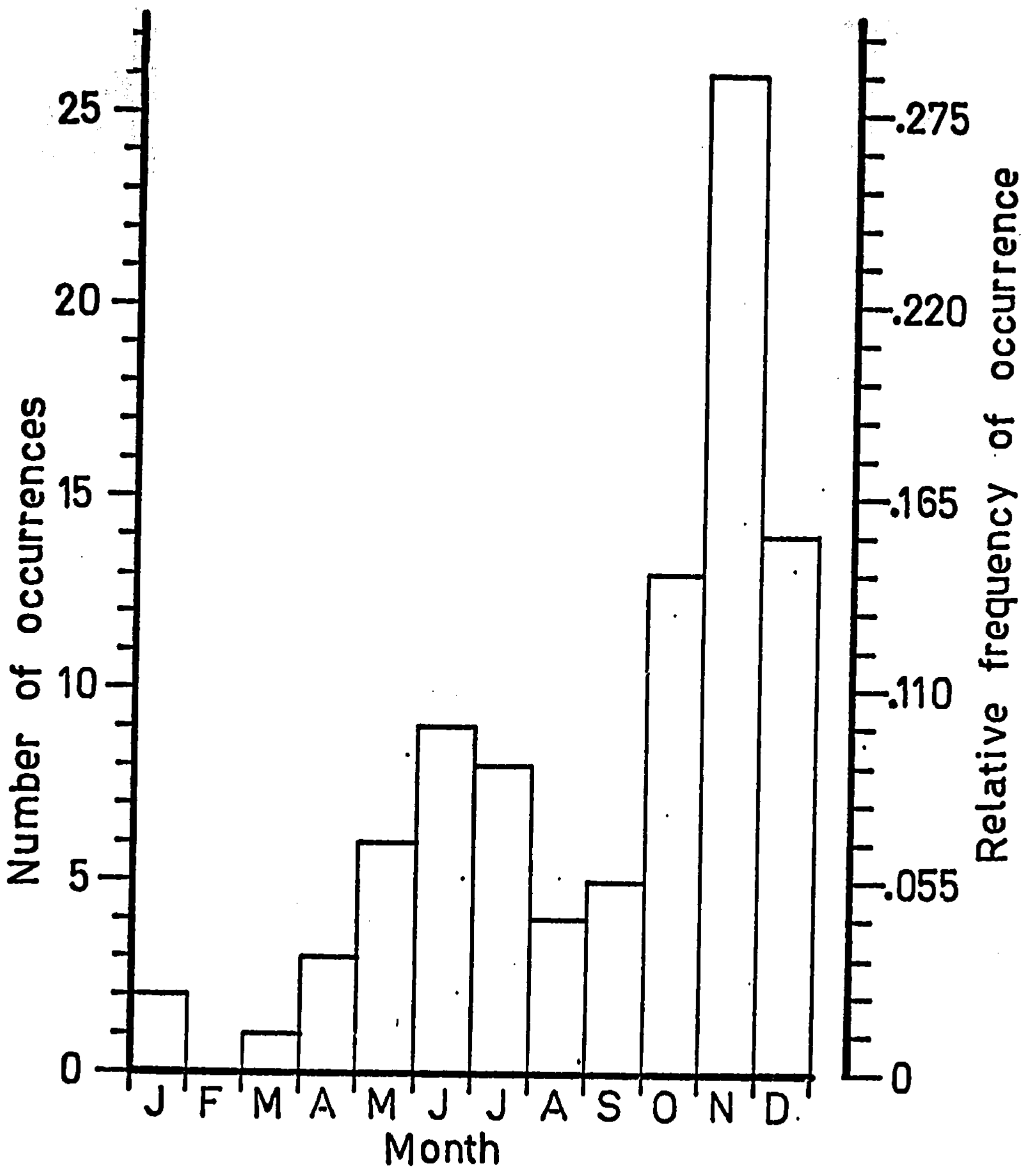


Figure 3.7. Tropical cyclones causing damage in the Bicol River Basin, 1884 - 1976

3.3.2 Hydrology

Stream Flow and Flooding:

There are three rivers in the project area: the Waras River in the north; the Barit River in the middle; and the Bicol River in the south-western section. Most of the project area drains into the Barit and Waras Rivers, which disappear into adjacent water-logged areas with no discharge outlet. Furthermore, portions of both the Barit and Waras Rivers are not even capable of draining a one-year flood. A long segment of the Waras River is clogged with weeds, and the existing waterway discontinues for about 1 kilometer in the section parallel to the highway between Nabua and Baao. The estimated capacity of the Barit River varies from 238 cms near Iriga City to 22 cms west of Nabua, near the project area center. Based on the analytical procedures discussed in Volume I, the peak discharges (in cms) of various return periods for the Barit and Waras Rivers in the project area are estimated, plotted in Figures 3.8 and 3.9, and tabulated as follows:

Table 3.4: Estimated peak river discharge, in cms

River	Return Period (years)					
	1	5	7	10	13	25
Barit	50	344	379	416	447	510
Waras	7	128	142	156	167	191

Some cross sections and estimated capacities of the Barit and Waras Rivers are shown in Annex C.

Rainfall:

The only rainfall gaging station within the project area is located in Nabua, Camarines Sur. Records at this station are only about 3 years long. There are six other rainfall gaging stations within 20 kilometers of the project area. The Buhi station with a daily record going back to 1950 with some missing data, has the longest daily rainfall data. The Buhi rainfall record is included in Annex C. Generally, rainfall data in the vicinity of the project area shows heavy rainfall during the period from June to December and less rainfall during the period from February to May. The annual rainfall in the BRIS Project area averages about 2700 mm. As far as the geographical variations in precipitation are concerned, the mean annual rainfall and the average of mean monthly rainfalls at the Buhi station are about 30 percent higher than the project area, as shown in Figures 3.10 to 3.14.*

*Arbhabhirama, A., Pescod, M.B., Tingsanchali, T., Okamoto, M., Sahagun, V.A. and Selvalingam, S. (1976), Surface Water Supply Study. Bicol River Basin, Research Report No. 54, Asian Institute of Technology, Bangkok, Thailand; January.

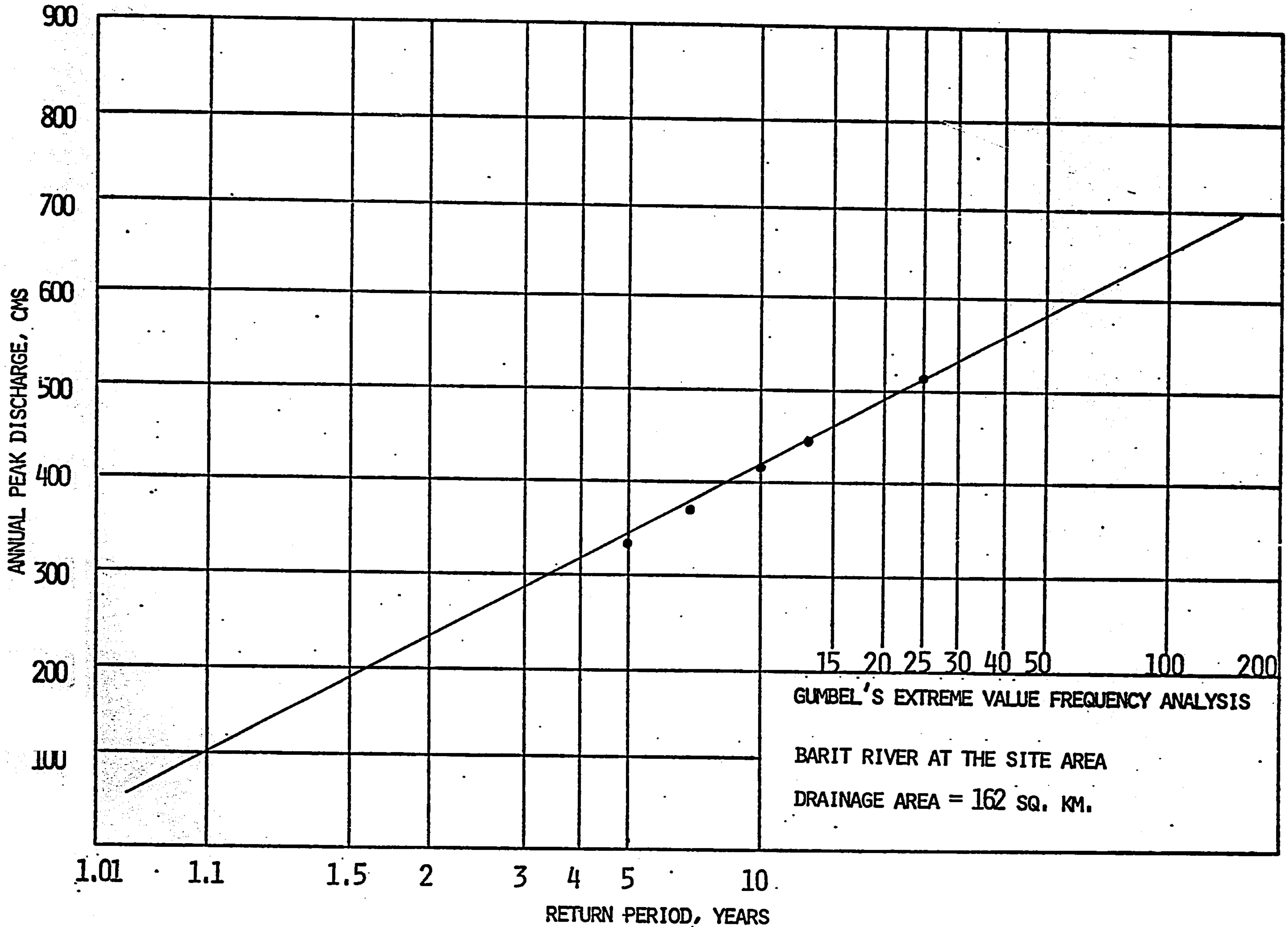


FIG. 3.8 FREQUENCY ANALYSIS OF ANNUAL PEAK DISCHARGE, BARIT RIVER, NABUA

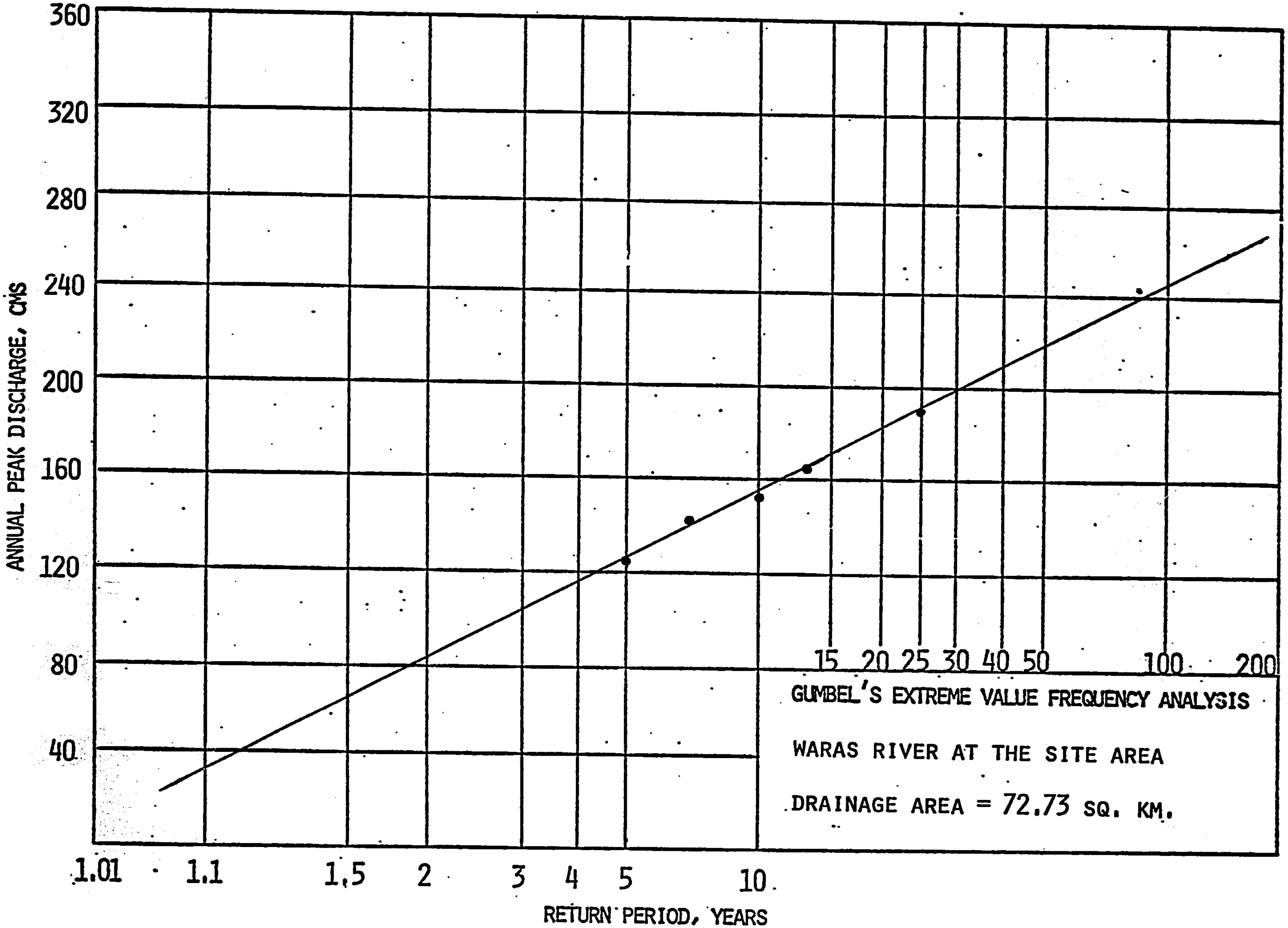


FIG. 3.9 FREQUENCY ANALYSIS OF ANNUAL PEAK DISCHARGE, WARAS RIVER, NARUA

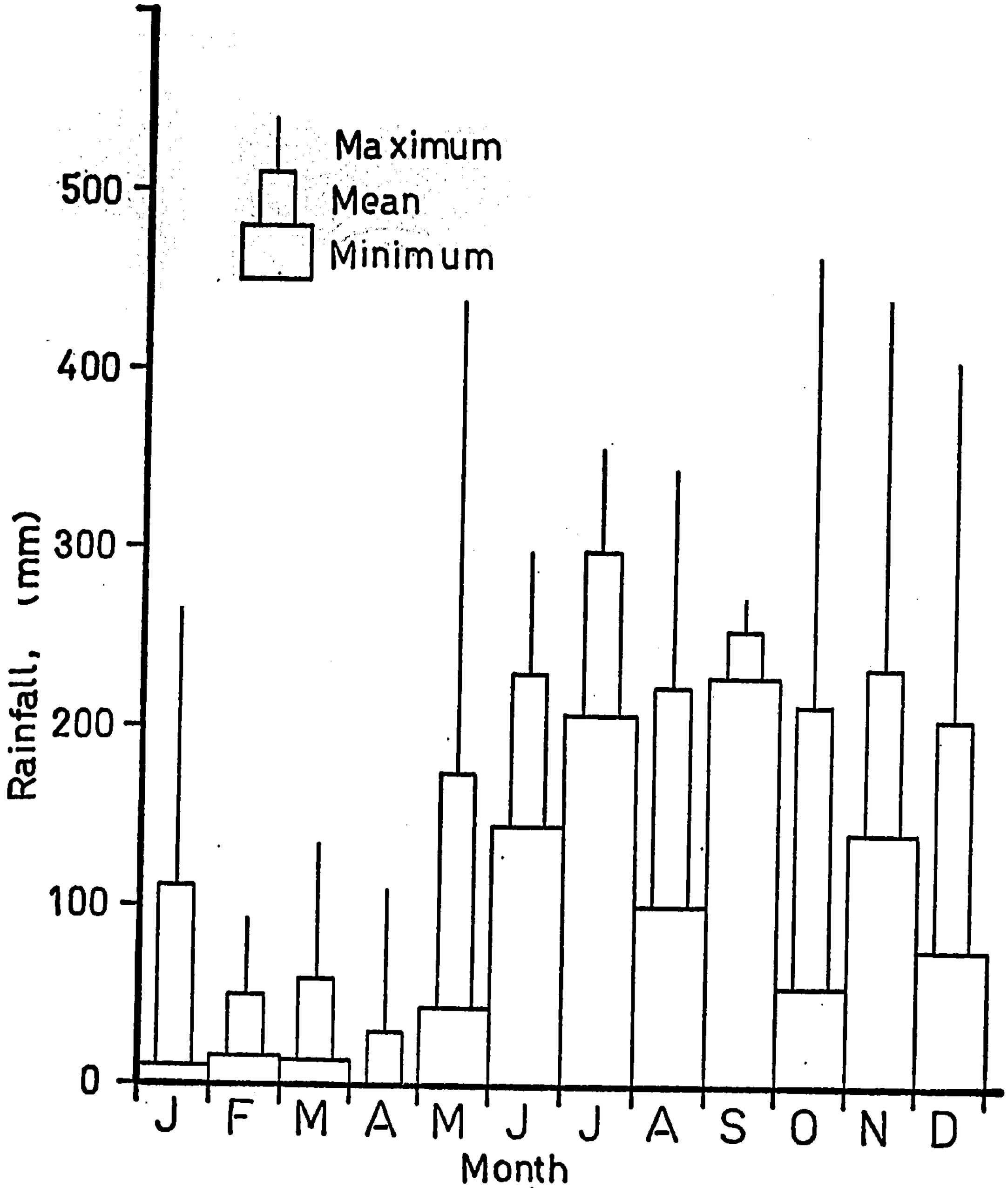


Figure 3.10. Rainfall, Sta. Cruz, Baao
1969-1973

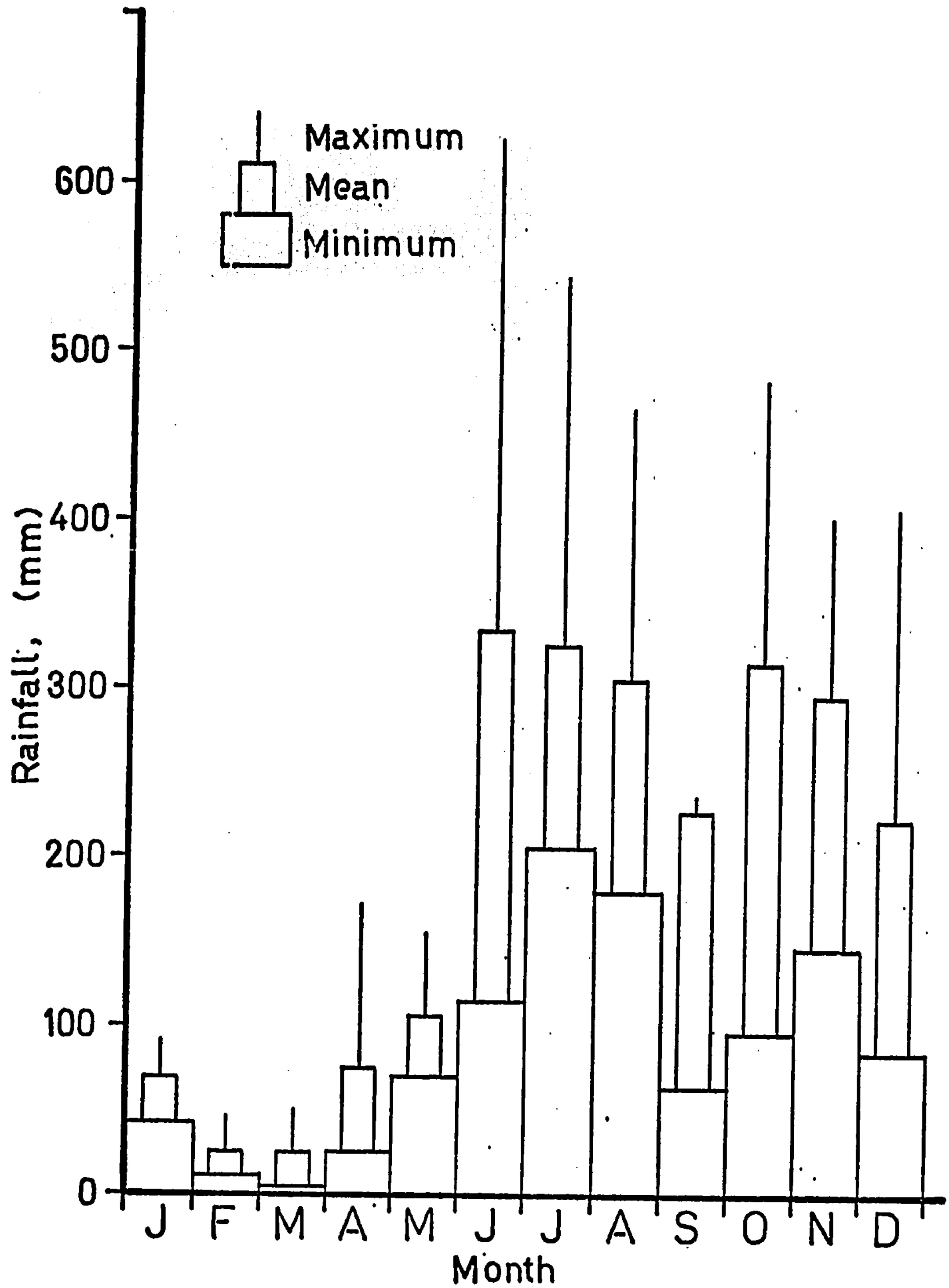


Figure 3.11. Rainfall, Barit RIS, Nabua
1972-1975

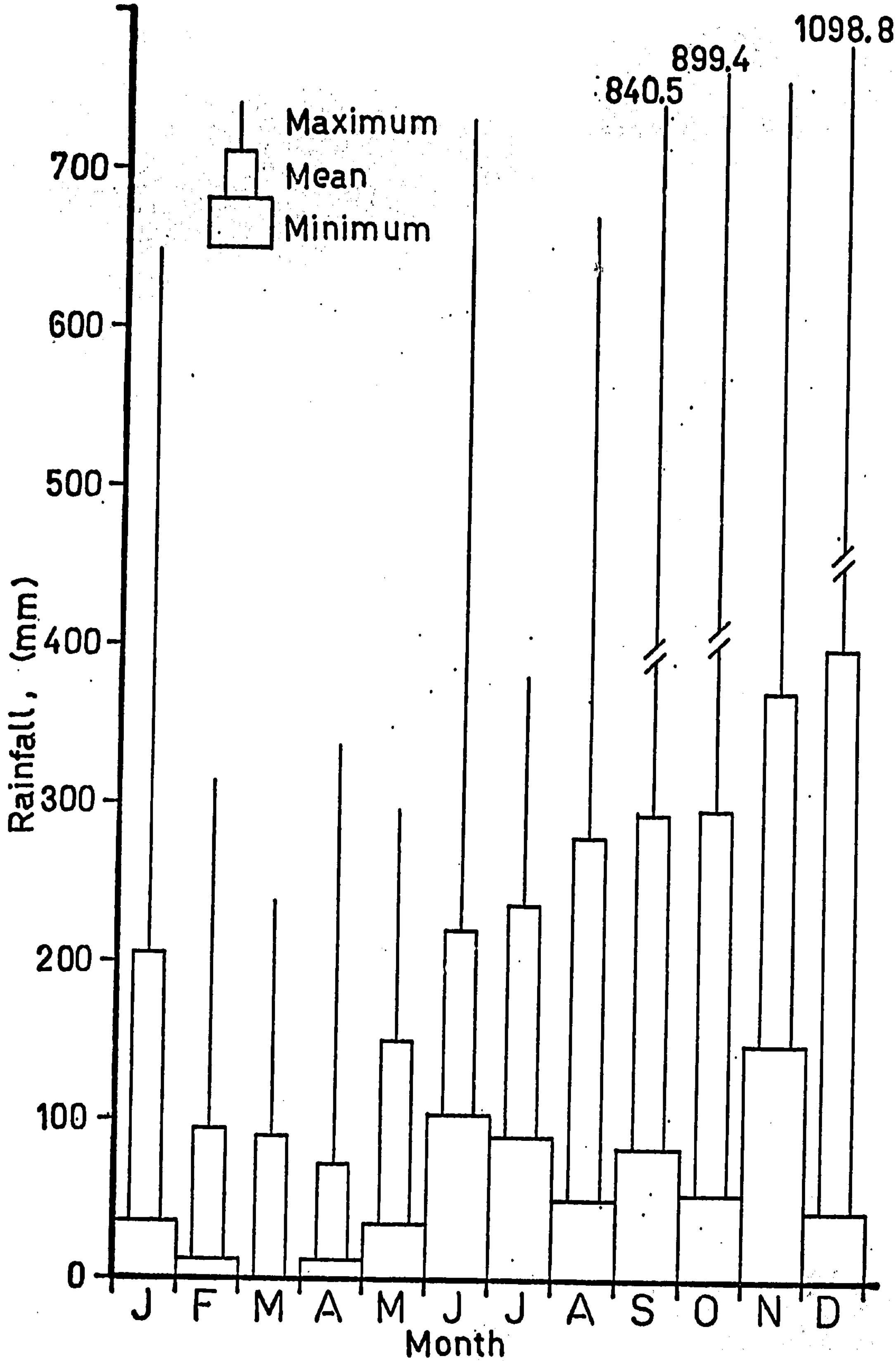


Figure 3.12. Rainfall, Buhi
1950 - 1969, 1971-1975

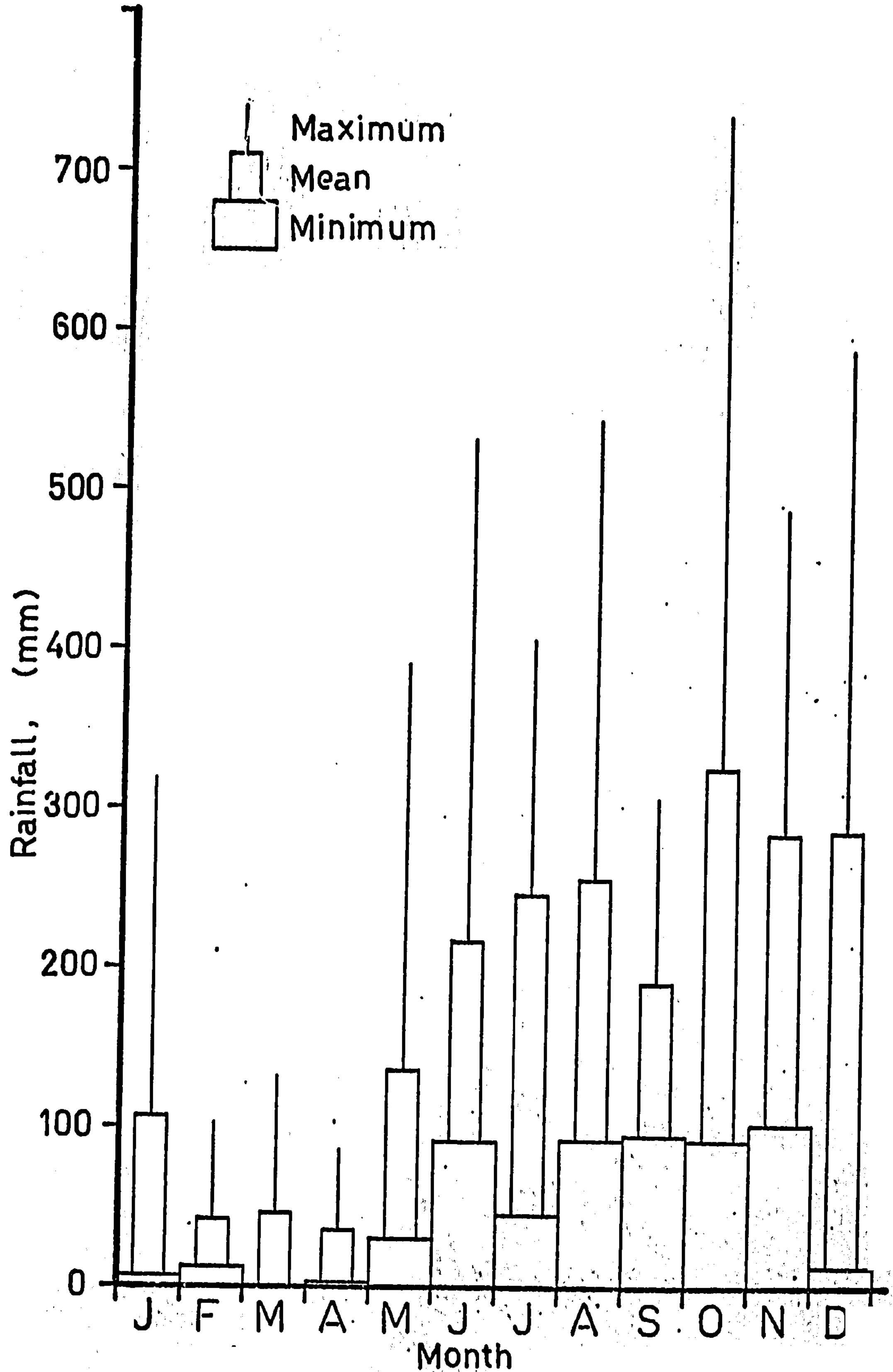


Figure 3.B. Rainfall, San Agustin, Pili
1966-1975

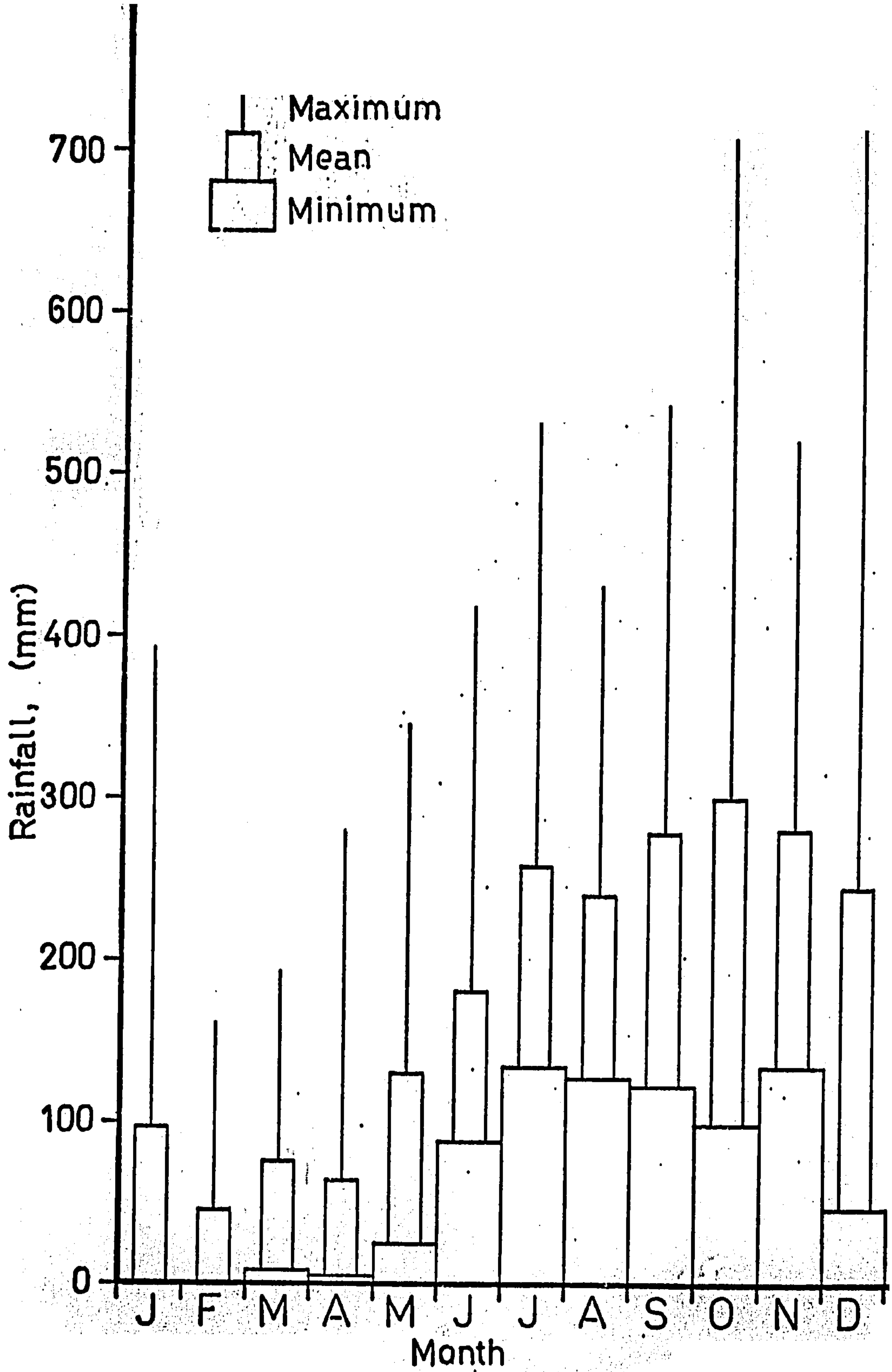


Figure 3.14 Rainfall, Yabo, Pili
1956 - 1967

The one to four days rainfall duration (in mm) of various return periods and different time periods at Buhi are obtained from the frequency analysis following procedures discussed in Volume I. The results are plotted in Figures 3.15 to 3.17 and tabulated in Table 3.5.

Table 3.5. Rainfalls of various return periods, durations and time periods (mm)

Duration (days)	Return Periods (years)				
	5	7	10	13	25
	Water Year - May 1 to April 30				
1	270.7	303.7	343.2	375.4	469.6
2	367.0	407.8	455.9	495.0	607.4
3	395.5	439.5	491.4	533.5	654.7
4	425.9	474.5	532.2	579.1	714.6
	December 1 to March 31				
1	167.0	189.9	217.5	240.4	308.5
2	228.0	260.3	299.5	332.1	429.7
3	251.8	282.3	318.7	348.5	435.3
4	284.9	324.8	373.2	413.3	533.1
	May 1 to August 31				
1	173.5	198.1	228.0	252.8	327.1
2	218.4	247.0	281.4	309.8	393.5
3	230.5	257.8	290.3	316.8	393.7
4	240.2	267.0	298.6	324.2	398.0

Effective Rainfall:

Effective rainfall is that part of the total rainfall during the growing season that is available to meet the consumptive-water requirement of the crop. Since actual consumptive use varies from day to day and daily consumptive use values are averaged daily rates for the month, the results should not be projected for periods of less than one month.

To be conservative, the average of the growing season rainfall for the five driest consecutive years is used in estimating effective rainfall in the design process. All rainfall less than or equal to consumptive use is considered effective. Light showers of rainfall intercepted by the plant contribute toward reducing consumptive use by reducing transpiration and, therefore, are considered effective.

Rainfall records from Buhi were used in computing the average daily rainfall. Assuming the dry season crop to be the most critical, then the period January through June, from 1961 to 1965 were the five driest consecutive years used in the calculations, Figure 3.18.

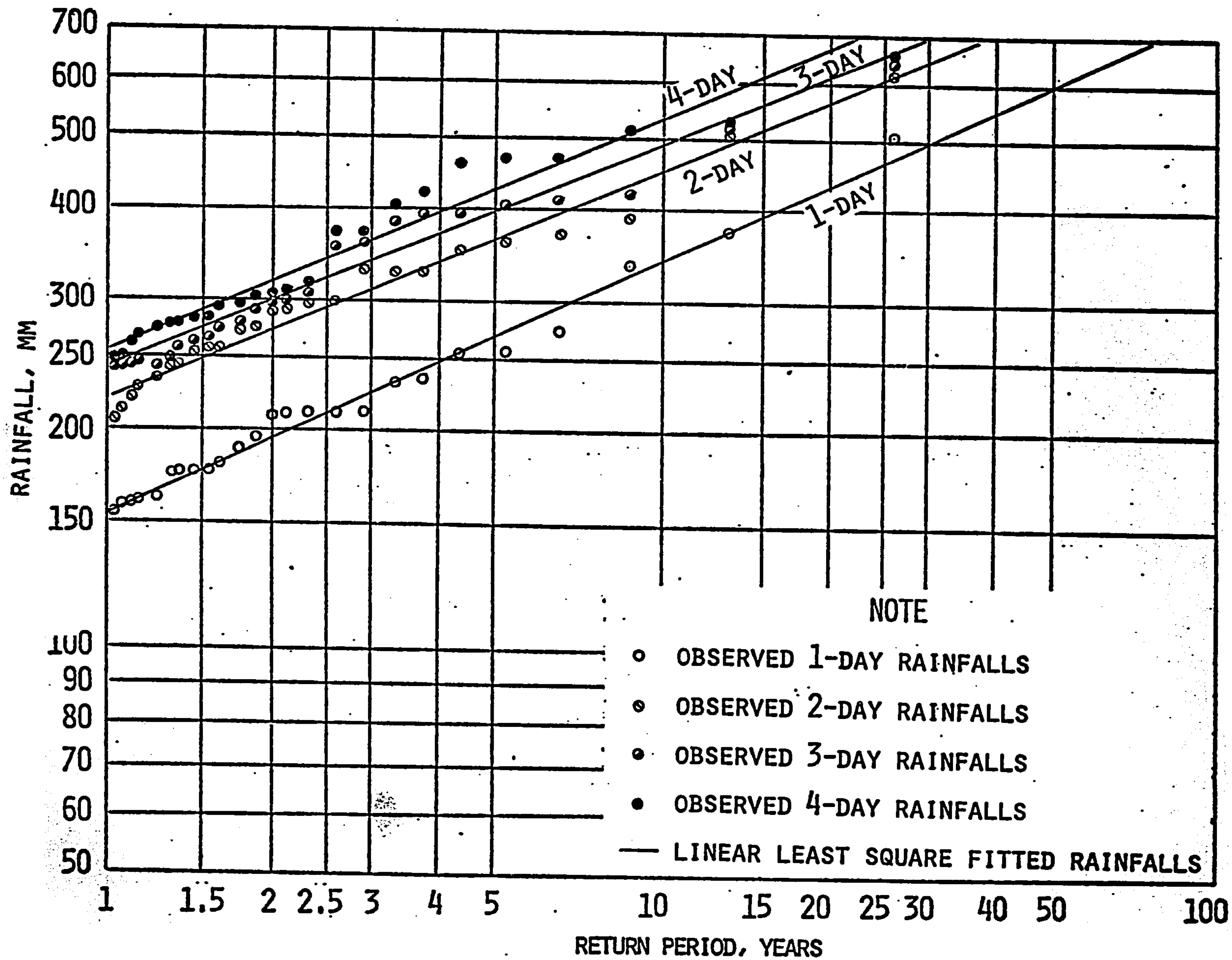


FIG. 3.15. PARTIAL SERIES RAINFALL FREQUENCY ANALYSIS, BUHI; C.S. WATER YEAR (MAY 1-APR. 30), 1950-69, 1971-75.

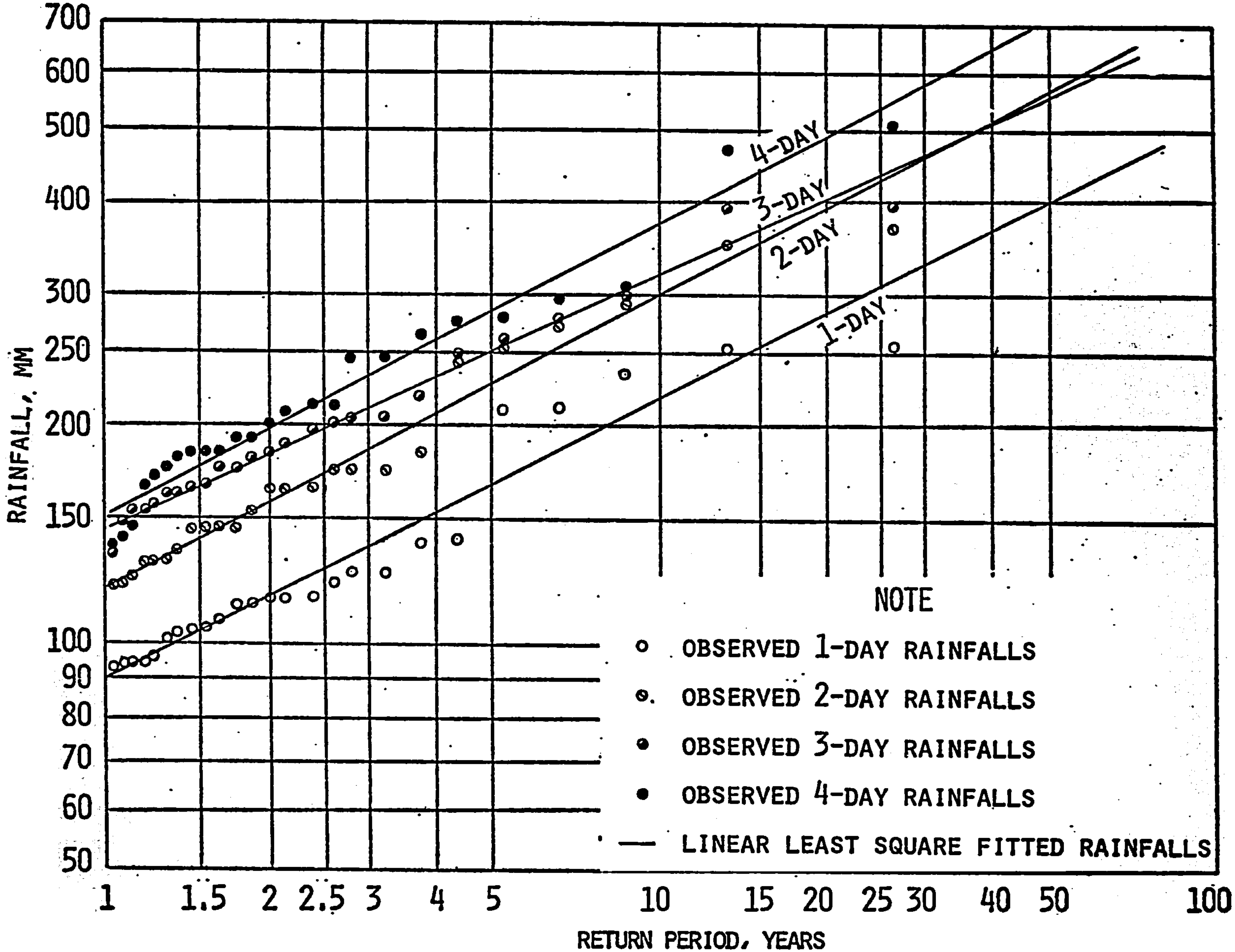


FIG. 3.16. PARTIAL SERIES RAINFALL FREQUENCY ANALYSIS, BUHI, C.S.
DEC. 1-MAR. 31, 1950-68, 1970-75

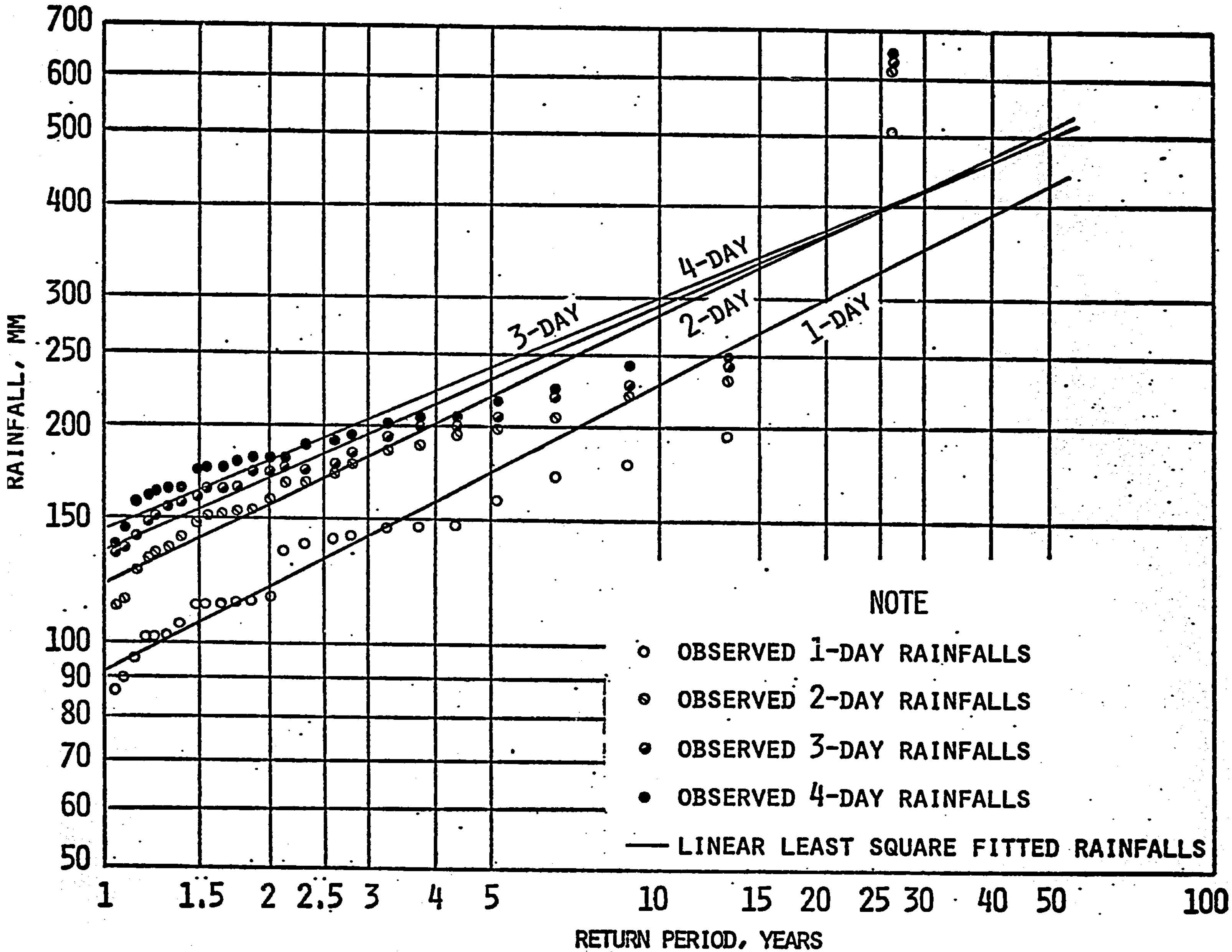


FIG. 3.17. PARTIAL SERIES RAINFALL FREQUENCY ANALYSIS, BUHI, C.S.
MAY 1-AUG. 31, 1950-69, 1971-75.

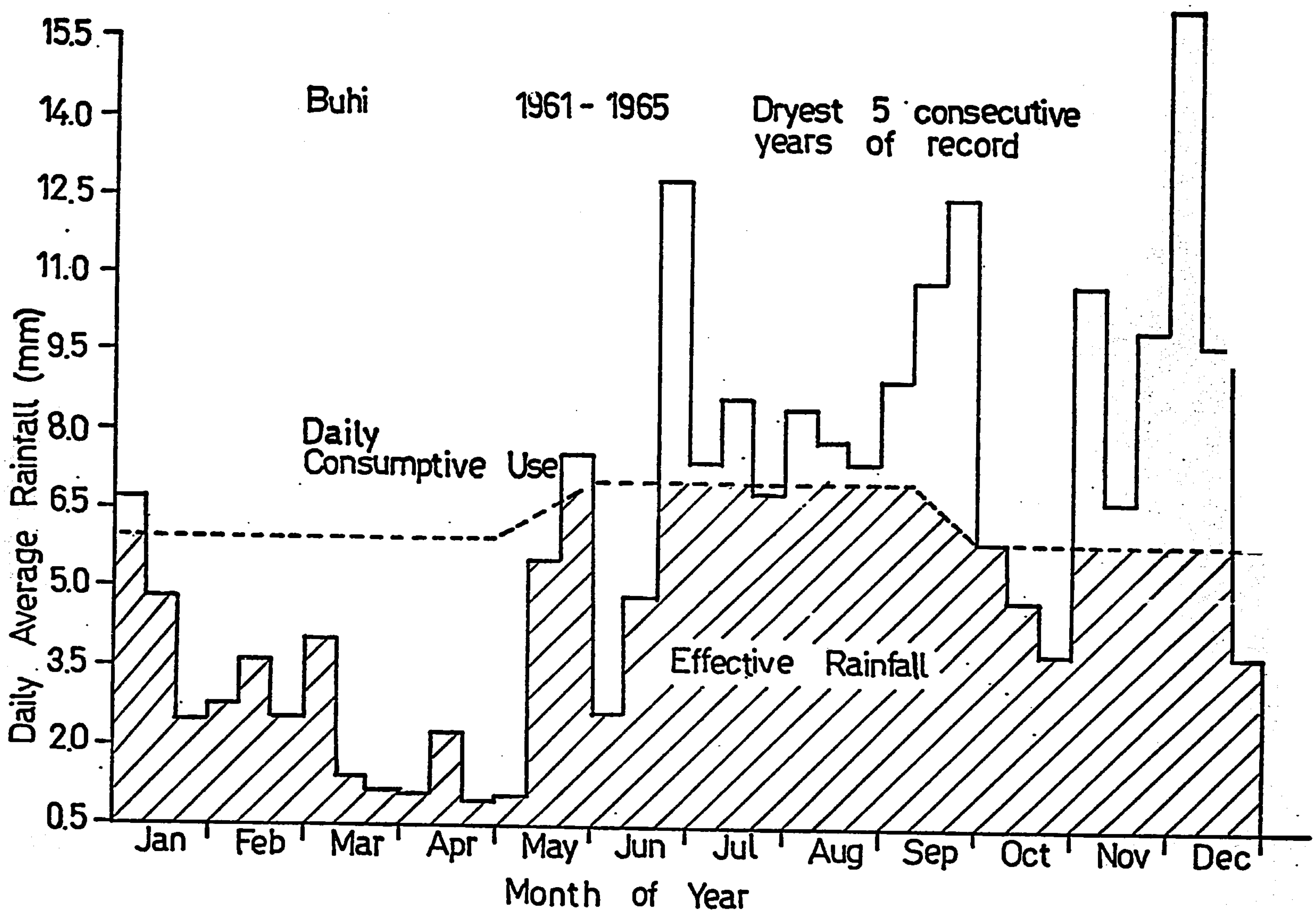


Figure 3.18. Effective rainfall for Site 1

The modified Blaney-Criddle formula* was used to calculate the evapotranspiration requirement. The maximum daily consumptive use was calculated to be 7.0 and 6.0 mm/day for the wet and dry seasons, respectively.

Water Requirements and Supply:

Using the improved formulae design procedures, Volume I, with a total land preparation period of 28 days, and assuming 60% system conveyance efficiency, the 2809.23 hectares of the BRIS will require 5.247 cms during land soaking and preparation, and 4.878 cms for field maintenance. Analysis of the low stream flow characteristics of the Barit River indicate a high probability that sufficient water may not be available during the dry part of the year. This period coincides with the start of land soaking and preparation for the wet season crop. There is a relative frequency of 0.81, Figures 3.19 and 3.20, that the minimum daily flow of the Barit River during this critical time will be less than 5.0 cms. This necessitates the development of an additional source of water (Lake Buhi). Further discussion on this topic can be found in Chapter 4, Section 4.

3.3.3 Topography and Soils

The greater portion of the Barit River Irrigation System lies on the broad plain between the Barit and Bicol Rivers. This portion is relatively flat with slopes less than 1%. A smaller portion of the project area extends into the foothills of Iriga mountain where paddy rice is grown in small valleys surrounded by uplands. See Figure 3.21 for the general outline of the BRIS project area.

Soils found in the BRIS project area are clay and clay loams which have been developed for paddy rice where possible. These soils are derived from volcanic ejecta and alluvium from higher landscapes which in most cases has been reworked by water. The infiltration rates range from very slow to moderately rapid with the latter lands being planted to coconut and other dryland crops. See Annex C for a description of the various soil series, infiltration and conductivity tests, and index to the soil maps.

*Davis, Calvin Victor, Handbook of Applied Hydraulics, Third edition, pp 33-38.

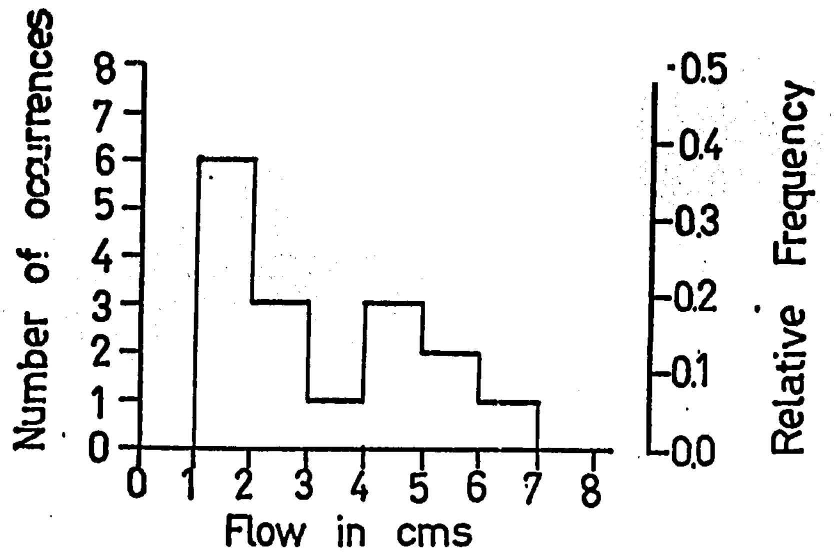


Figure 3.19. Histogram of minimum annual daily flows for the Barit River

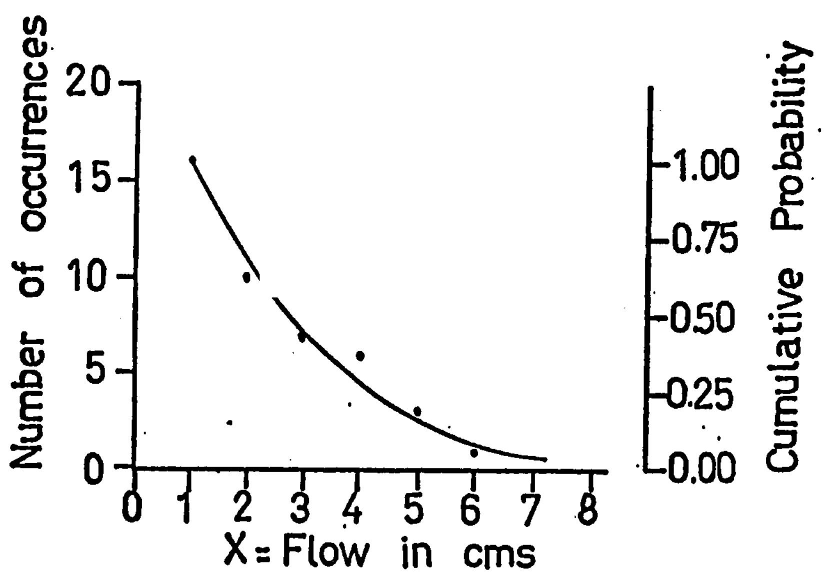


Figure 3.20. The probability that the minimum annual flow will be equal to or ter than X

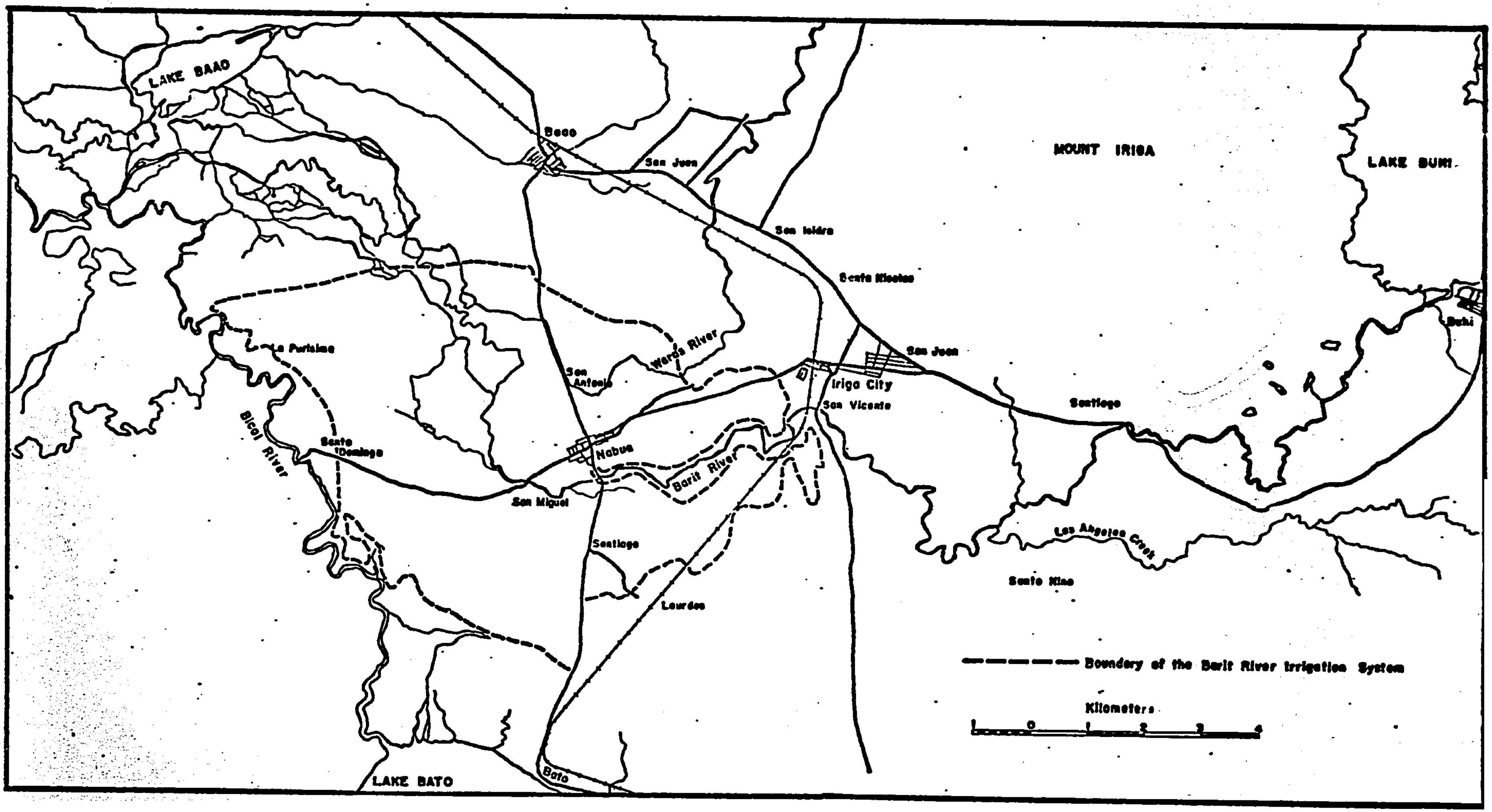


Figure 3.21 Watercourses influencing the engineering design of the project area.

CHAPTER 4. OVERVIEW OF PROJECT COMPONENTS

The recommended development program consists of two parts. A farm management and water management program describes the recommended combination of farm management and water management practices for BRIS which seeks to achieve the greatest benefits with least risk for rice producers in BRIS. This portion of the program does not have any cost components directly associated with it. However the farm management and water management recommendations provided the basic assumptions for 1) estimating benefits and 2) developing design criteria for the physical and socio-infrastructural components for which cost estimates were derived.

The investment program contained in this project consists of five components. Component 1 includes 1) the construction of new main canals and rehabilitation and enlargement of existing main canals and their maintenance, 2) construction of new and rehabilitation and enlargement of existing lateral and sub-lateral canals, 3) construction and maintenance of new farm ditches, 4) construction and maintenance of drainage facilities among farm holdings, and 5) construction and maintenance of farm roads along the main canals, lateral and sub-lateral canals, and other areas in the BRIS. Component 2 includes the excavation and maintenance of external drainage canals to convey excess water and run-off from the project area. Component 3 includes the construction of structures to increase the storage capacity of Lake Buhi. Component 4 provides for the organization of local associations of water users which will assume responsibility for distributing water among themselves. Component 5 is a program to increase the tenure security among share-tenants in the project area.

4.1 Farm Management and Water Management

The recommended improvements to BRIS are based on an assumption that farmers in the project area will produce two rice crops of 105 days of duration. Analysis of storm frequencies and water availability suggest that the dry season crop should be planted in December to January; the wet season crop should be planted in May. This cropping schedule is designed to permit farmers to produce two crops, and allows them to harvest prior to October and November, when the incidence of severe storms is greatest.

Consideration was also given to a program which would include 2.5 crops per year (five crops in two years). However, the potential benefits of such a farm management program were not great. Also, relative to a farm management and water management program which includes two crops per year, the farm management and water management program which would achieve five crops in two years was more complex. While a farm management and water management program which would produce five crops in two years appears to have merit in the long run; the program which would achieve two crops in one year involves less radical departures from existing practices and can be implemented immediately. Subsequent experimentation and analysis of more intensive farm management and water management programs may suggest opportunities for initiating a more intensive program.

The employment consequences of alternative levels of mechnization and lengths of transplanting period were also examined. This analysis sought to determine if there are any substantial income and employment benefits that would accrue to farm laborers as a result of different levels of mechanization (hand-tractors and treshers) of farm operations or different lengths of transplanting period. The analysis indicated that for water distribution schedules which require shorter transplanting periods (1 day per hectare rather than 4 days per hectare) some minor increases in hired labor requirements would be generated at transplanting and harvest periods. No differences in employment opportunities at other periods of the crop season resulted from variations in the water distribution schedule. Water distribution schedules which allow farmers only one day for transplanting probably would cause them difficulty in managing their farm, particularly if they have to manage more than one parcel. The more restrictive water distribution schedules would also probably encourage violations among farmers. For these reasons, a water distribution schedule which allows farmers four days in which to transplant and does not require mechanization (beyond that of a hand-powered, paddle-wheel type weeder) is recommended. See Chapter Five for details of the recommended farm management and water management program.

4.2 Component 1: Major Conveyance Facilities

4.2.1 Main Canals Currently, farmers in the area are served by one main canal. This canal extends for about 18 kilometers. In addition, a portion of a lateral canal (Lateral A) is used an another main canal. Improvements and additions to both of these facilities are recommended. See Chapter Six for details.

The first seven kilometers of the existing main canal is of sufficient size to convey the required amount of water. However, the next eleven kilometers must be enlarged. Also, the existing main canal should be extended for an additional 500 meters. This extension will allow the BRIS to provide irrigation services to farmers on about 125 hectares.

A second main canal should be constructed by modifying Lateral A and a portion of Lateral A.2. This second main canal will diverge from the principle main canal at its current junction with Lateral A. At the junction of Lateral A with the main canal, Lateral A should be enlarged to provide a carrying capacity of 2.07 cms. Both Lateral A and the portion of Lateral A.2 which will serve as a second main canal should be enlarged throughout their length.

It also appears that Lateral A.2 should be extended for an additional 500 meters. This recommendation is contingent on the results of a more detailed survey to determine the most appropriate junction for the terminal lateral canal. For purposes of the economic analysis in this study the extension was included.

4.2.2 Lateral and Sub-Lateral Canals Presently, the BRIS contains 14 lateral and sub-lateral canals. Four of these should be extended. The conveyance capacity of ten of these should be enlarged. Also, 13 new lateral canals and 25 sub-lateral canals should be constructed. See Chapter Six for details.

The proposed improvements and additions will enable BRIS to reduce the length of the farm ditches receiving water from these canals. Currently, some farm ditches are more than two kilometers long. If the recommended lateral and sub-lateral canals are constructed, it will not be necessary for any farm ditch to exceed one kilometer in length.

The recommendations are based on an analysis of maps provided by the National Irrigation Administration (NIA) which describe the canal layouts in BRIS as of July 1975. Also used was a list obtained from NIA which describes the lateral canal characteristics of the existing lateral canals. This list was prepared in the 1960's and should be reexamined to determine if important changes have occurred.

4.2.3 Farm Ditches About 208 kilometers of farm ditches should be constructed. Most of the existing farm ditches have insufficient carrying capacity. All of them appear to require rehabilitation. The proposed improvements will upgrade the farm ditch to satisfy NIA standards. See Chapter Nine for details.

With these improvements, all farm ditches will extend for less than one kilometer. Construction of the recommended network of farm ditches will not provide all farmers with direct access to a farm ditch. However, this network will insure that all farm plots will be less than 300 meters from a farm ditch. Three hundred meters was used as a design criteria because it appears that 300 meters is the maximum distance which water can travel in one day via "cross-paddy flow". Farmers must be able to obtain irrigation water within one day to follow the recommended pattern of rotational water distribution and the associated cropping schedule.

4.2.4 Farm Drains The existing system density of 11 meters per hectare is below the lower acceptable limit issued by the NIA of 13 meters per hectare for construction of new projects. During storms and heavy rains, about one-third of the irrigated area is submerged. In addition to this, due to the construction of illegal diversion dams by private individuals, about 156 hectares of the project area is inundated and is not suitable for cultivation. Also, 26 hectares suffer from drainage problems because of a diversion road.

About 127 kilometers of primary and secondary farm drains should be excavated to remove excess water from the paddy fields during storms. If this network is constructed, paddy fields will be protected against inundations which exceed 20 centimeters for more than three days, for an average of four out of every five years. A five year return period was used as the basis for the design criteria because storms which exceed this degree of severity are also likely to cause damages from wind and pelting rain which cannot be prevented by construction of drains. Since drains cannot protect against this type of damage, the drainage network was designed to protect only against damage from inundation.

Rainfall records from the power station, which is about 4.5 kilometers downstream from Lake Buhi, were used to determine the design criteria for the proposed drainage network. Since the rainfall which occurs at the power station is about 1.3 times that which falls in the BRIS, the proposed drains were designed to accomodate the run-off results from the rainfall which is 77 percent of that which occurs at the power station.

4.2.5 Farm Roads The road density in the BRIS should be increased from the existing 20 meters per hectare to 40. About 9 kilometers of roads with a five meter top width, and 50 kilometers of roads with a four meter top width should be constructed. The larger roads will be located in more heavily traveled areas; the smaller roads will be located in less heavily traveled areas.

Currently, portions of the route along the proposed main canals are not directly accessable via road. If the proposed additional 9 kilometers of road are constructed along the main canals, virtually the entire length of the main canals will be adjacent to a five meter road. A short length along the route of the proposed main canals (at the current junction of Lateral A and Lateral A.2) will be about 50 meters from a service road.

About 50 kilometers of road should be constructed along the lateral canals, along several farm ditches, and to critical points in the farm drainage network. If these are completed, no farm plot will be more than 500 meters from a road.

4.2.6 Maintenance It will be necessary to clean the main canals, lateral and sub-lateral canals, and the drainage canals. The farm roads will occasionally require resurfacing. We assume that the farmers associations will assume responsibility for maintaining the farm ditches. Maintenance costs for the proposed roads and canals are estimated to be 3 percent per year of the total construction costs of the entire physical system, excluding the farm ditches.

4.3 Component 2: External Drain

Most surface run-off from the project area drains into the Barit and Waras Rivers. These, in turn, drain into adjacent water logged areas near Lake Baao. Currently existing natural drains should be improved to convey run-off from the project area more rapidly.

4.3.1 Recommended Improvements The five year peak discharge in the Waras River is about 128 cms. About four kilometers of the River have a discharge capacity of between 0 to 22 cms. About 170,000 cubic meters of earth should be dredged from the river to enlarge it to the required size.

The five year peak discharge in the Barit River is about 344 cms. The land classification maps indicate that only portions of the land which is adjacent to downstream reaches of the Barit River are subject to flooding. About three kilometers of the downstream portion of the Barit River should be enlarged to a capacity of 172 cms. About 130,000 cubic meters of earth will have to be dredged to achieve this capacity.

This run-off will be drained into water-logged areas which are adjacent to Lake Baao. The proposed drainage network for the BRIS, is not expected to exacerbate the water-logging in this area, but it will not alleviate it either. To alleviate inundations around Lake Baao, drainage facilities which convey run-off from Lake Baao area to downstream areas will have to be constructed. Consideration of these improvements were beyond the scope of this investgation, see Chapter 7.

4.3.2 Maintenance Details of maintenace requirements for the proposed external drain have not been precisely identified. For the sake of economic analysis, we assume that the annual maintenance costs for the external drain should equal 3 percent of the total construction cost.

4.4 Component 3: Increase Storage Capacity of Lake Buhi

During periods in some years the Barit River may have insufficient flow to supply the water requirements for two rice crops. With the proposed advance dates for land preparation and transplanting during the wet season, water deficits are most likely to occur during land preparation in the wet season (April and May) and may occur in the middle of the growing period in the wet season when maintenance water is required.

Land soaking for the wet season is scheduled to occur between April 22 and May 20. Between 1954 and 1966, the lowest recorded flow rate for the Barit River was 1.2 cms. This occurred in May 1963. Water requirements during land preparation suggest that a stream flow of 5.3 cms will be required at this time. To insure that adequate water is available at these times, an additional 4.1 cms may have to be drawn from Lake Buhi.

During the maintenance watering period, May 21 to August 15, the stream flow can decrease to less than the required 4.9 cms for as long as 20 days. The largest recorded deficit occurred during late June and early July 1966 and 1968. The stream flow at these times decreased to about 1.4 cms. An additional 3.5 cms may have to be drawn from Lake Buhi during these periods, see Chapter 8.

4.4.1 Recommended Improvements To protect against the occurence of these water deficits, the usable storage capacity of Lake Buhi should be increased by 19,000,000 cubic meters. This can be achieved by installing control structures at each of the outlets from Lake Buhi to increase the level of the lake by 1.5 meters.

Detailed plans for these structures should be developed and examined. For the purposes of this analysis, the prefeasibility recommendations of TAMS/TAE were used. The TAMS/TAE recommendations, however, relate to the entire Rinconada IAD, while BRIS includes only a portion of the Rinconada IAD. The TAMS/TAE prefeasibility recommendation suggested that the level of Lake Buhi should be increased by 3.5 meters. For the purposes of this study, the costs associated with increasing the storage capacity of Lake Buhi were estimated by determining the portion of the TAMS/TAE recommendation which would be directly attributable to the BRIS.

4.4.2 Maintenance These self-operating concrete structures will require periodic lubrication and inspection. Maintenance costs for these structures were estimated to amount to 0.1 percent of the total construction costs.

4.5 Farmer Organization and Training

To expeditiously obtain the potential benefits of the proposed improvements it will be necessary to create organizations of water users within the terminal distribution units and to help farmers acquire the skills necessary to emple-ment the proposed farm management and water management program. Responsibility for operating and maintaining the BRIS is proposed to be ultimately delegated to a system-wide organization of water users within five years from the initiation of the project. This component contains recommendations which are designed to achieve both the immediate and long term objectives. See Chapter Nine for details.

4.5.1 Training and Organization of Water Users The first portion of the component contains provisions which are designed to 1) train water users with the necessary farm management and water management skills 2) and organize farmers into water user associations within the terminal distribution units. Training will be conducted at two levels. Project component implementors, who will organize water user associations, will acquire the required skills to organize and train farmers. Farmer beneficiaries will acquire required skills in management, farm management, and water management.

Water user associations in the terminal distribution units will be formed. These organizations will be based on the principles of compact farms. They will also be organized on the basis of hydrologic boundaries given by the physical lay-out of the irrigation system.

4.5.2 Organization of a System-Wide Water Users Association The ultimate desire is to create a system-wide water users association which can assume responsibility for operating and maintaining the system. A general plan for accomplishing this objective within two years from the date of completion of construction is presented. It appears to be highly desireable to obtain the services of a consultant to review and develop specific recommendations relative to this general plan. This review should be conducted as soon as possible.

4.6 Tenural Development

About 2,434 farmers (36.5 percent) in BRIS are share-tenants and lessees. As described in Presidential Decrees No. 27 and 474, the government of the Philippines is committed and the BRBDP in instructed to assist the 2,434 share tenants and leasees to become amortizing land owners. This project component contains a program to accopmplish that objective. See Chapter Ten for details.

CHAPTER 5. WATER AND FARM MANAGEMENT

Water distribution schedules interact with the crop schedule to such an extent that it is meaningless to develop a water distribution plan without having a cropping plan established. Therefore a cropping schedule is established first, then the water distribution plan is completed.

5.1 Cropping Schedule

The basic considerations in the establishment of an optimal cropping schedule are solar radiation, temperature, rainfall, water availability, labor availability, occurrence of strong wind and damaging cyclones.

The International Rice Research Institute, in its 1973 annual report, proposed that there is a high correlation between the Estimated Yield Potential (EYP) for their IR747 line, and temperature and solar radiation during the 25-day period before flowering. The IR747 line matures 96 days from sowing to harvest. It has not yet been released for general production purposes. However, it is an early maturing variety not unlike the 105-day variety which is being recommended for BRIS. Therefore, the finding is applied to evaluate the relative goodness of alternative cropping schedules.

$$\text{Estimated Yield Potential (EYP)} = 2.065 \times (278-7.07T) \times S$$

Where T = daily mean temperature, degree C
S = daily solar radiation, $\text{watts/m}^2\text{/day}$

In the evaluation of alternative production schedules, adjustments must be made to account for the effect of cyclone occurrences. This can be done by estimating the probability of cyclone occurrences in the production cycle and then reduce the EYP by a factor proportional to the probability of damaging cyclone occurrence. Three alternative production schedules were studied, Figure 5 .1, and the results are shown in Table 5.1.

1. Schedule 1

The basic approach in Schedule 1 was to minimize cyclone damages. The wet season harvest was scheduled to be completed before October and the 105-day variety is chosen so that flowering will fall in the month of August, another month of relatively low cyclone occurrence. The dry season crop schedule is optimized using both temperature and solar radiation. Two crops are scheduled every year, with no rice cropping activity during the months of October, November and portions of December.

2. Schedule 2

In Schedule 2, the emphasis is placed on the maximization of solar radiation received by the two crops during the period 55 days prior to harvest.

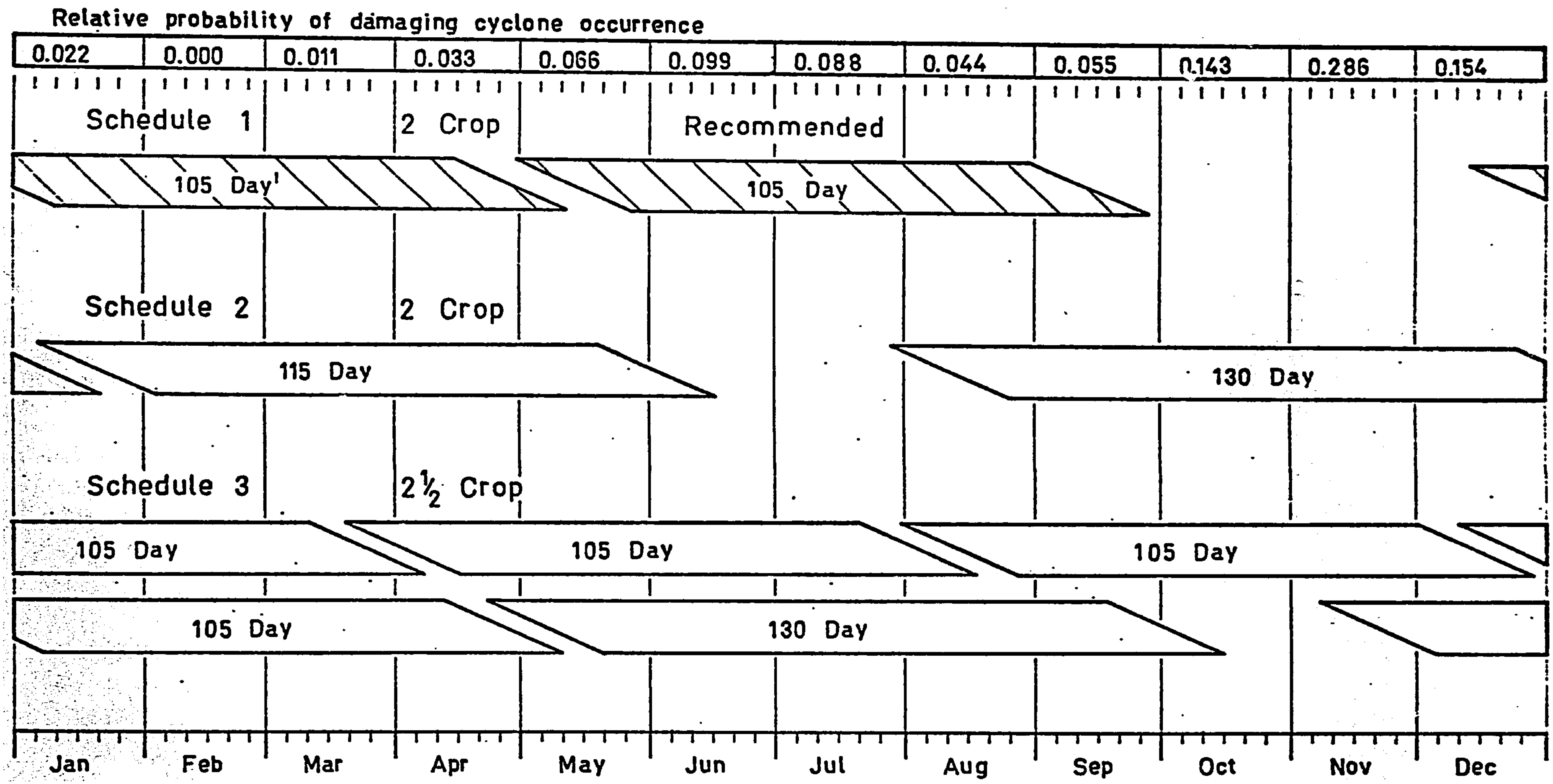


Figure 5.1. Alternative rice cropping schedules

[1] Length of growing season, sowing to maturity.

Table 5.1. Analysis of alternative rice crop production schedules for the Bicol River Basin Region

Crop Season Periods Schedules	55 Days before harvest				Probability of cyclone damage	Adjusted EYP to include anticipated cyclone damage
	Date	Mean Temperature °C (T)	Mean Solar Radiation W/m^2-day (S)	Estimated Yield[1] Potential (EYP)	Season (PS)	EYP (1-PS)
Schedule 1						
27 Dec. – 28 Apr.	2 Mar.	24.8	193.63	41,050.6	0.099	36,968.6
14 May – 13 Sep.	18 Jul.	27.2	153.40	27,146.0	0.352	17,590.6
						54,577.2
				Adjusted EYP for two years =		109,154.4
Schedule 2						
21 Jan. – 2 Jun.	6 Apr.	26.8	205.28	37,526.0	0.182	30,696.3
12 Aug. – 7 Jan.	11 Nov.	26.0	167.41	32,558.6	0.693	9,995.5
						40,691.8
				Adjusted EYP for two years =		81,383.6
Schedule 3						
3 Apr. – 3 Aug.	7 Jun.	28.3	180.19	28,992.7	0.314	19,889.0
14 Aug. – 14 Dec.	18 Oct.	26.6	155.82	28,939.9	0.682	9,202.9
25 Dec. – 26 Apr.	24 Feb.	24.8	190.24	40,331.7	0.165	33,677.0
7 May – 1 Oct.	5 Aug.	27.3	144.43	25,347.4	0.435	14,321.3
22 Nov. – 24 Mar.	26 Jan.	24.8	164.13	34,795.8	0.341	22,930.4
				Adjusted EYP for two years =		100,020.6

[1] IRRI, Annual Report 1973, pp. 48-50; EYP = (278 – 7.07T)*2.065S where 2.065 converts w/m^2-day to cal/cm^2-day.

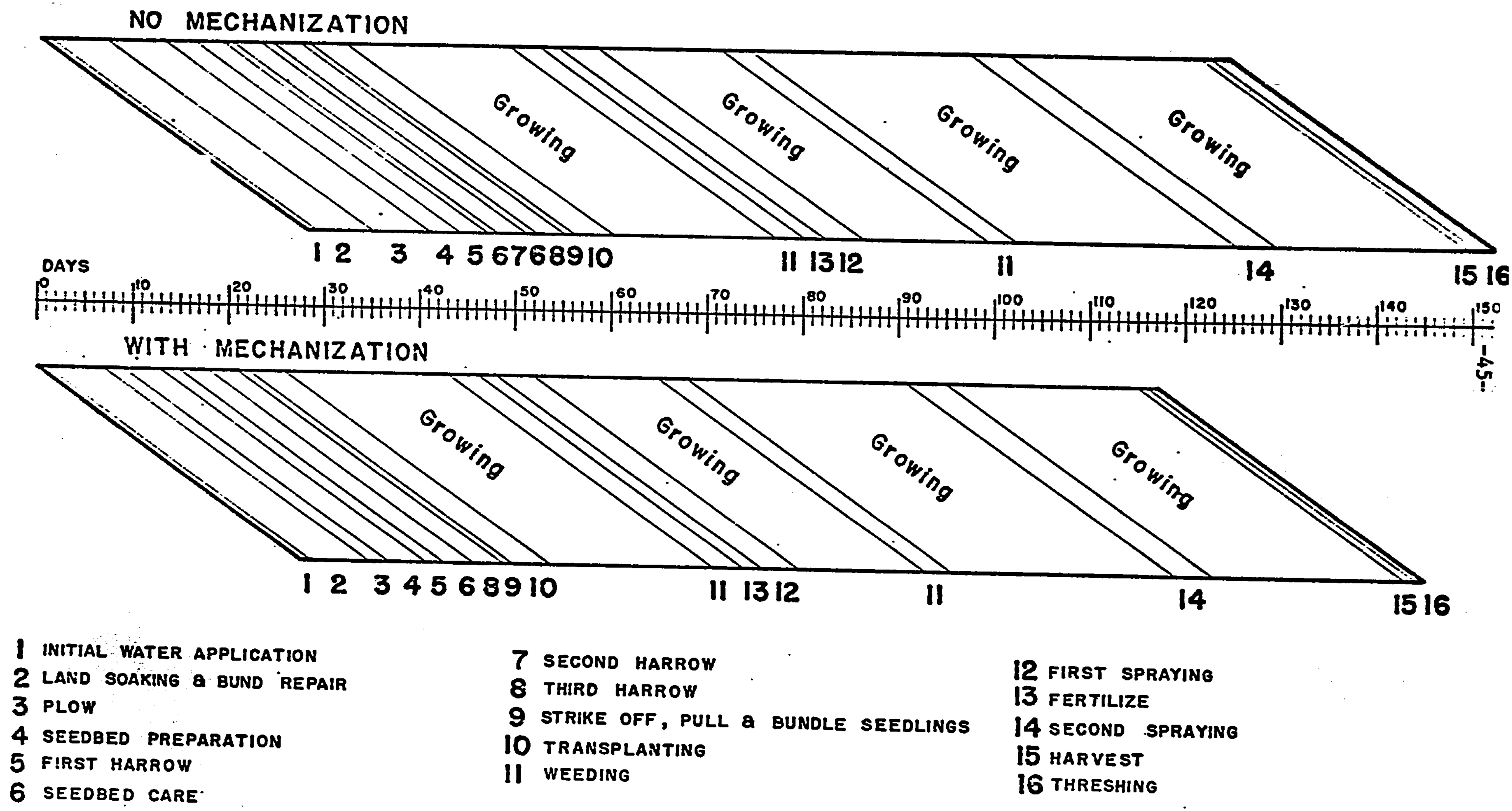


Figure 5.2. Rice production activities for IR-28, 105 days from seeding to maturity.

3. Schedule 3

By using a 105-day variety, 2½ rice crops can be scheduled per year, or 5 crops can be produced in 2 years. There is a widely held belief that a 2½ cropping schedule would diffuse the risk of cyclone damage and, because of its higher intensity in land utilization, will out-produce the 2-crop per year schedule. Schedule 3 is adopted from one of the cropping schedules suggested for the Libmanan-Cabusao IAD.

Despite the higher land utilization intensity of Schedule 3, the adjusted EYP of Schedule 1 is approximately 10% better than Schedule 3 which has 2½ crops per annum. This suggests the strong influence of cyclone-caused damages on rice production in the Bicol River Basin area

Because of the procedure used in calculating the adjusted EYP, there can be no assurance that the results are accurate to the 10% range. But even if the difference in adjusted EYP between Schedules 1 and 3 is disregarded, the total production cost for Schedule 3 would be close to 125% of the production cost of Schedule 1. Furthermore, the two crops per year, using 105-day varieties, allows time for irrigation and drainage systems maintenance and farmer education.

Therefore, Schedule 1 is adopted in the overall production system design.

Looking toward the future, it is recommended that additional crops, for example ducks, and other productive activities, for example, family handicraft industries, be developed to take advantage of the 2 to 3 months of time when no direct rice farming activity is scheduled. It is also recommended that NIA develop a system maintenance schedule to generate employment opportunities during this idle period.

5.2 <u>Water Distribution</u>

The recommended crop schedule requires the initial soaking water to be distributed to the active irrigable area in 28 days. Annex C, Figure 14 and Table 4, give a water distribution plan that will meet this requirement.

The proposed water distribution plan starts with rotation by lateral section and at a later time, when the management capabilities of the irrigators groups have developed, transition to rotation by farm ditch.

5.2.1 <u>BRIS Water Distribution Plan</u> Under present conditions, NIA personnel control the water down to the heads of the main terminal facilities. Since they have this expertise, implimentation problems can be diminished by having NIA continue this control until such time as the Irrigators Association is able to assume these responsibilities.

5.2.2 <u>Water Management in the Terminal Units</u> Water distribution and facility maintenance below the lateral canal level will be handled by the Compact Farm members, refer to 9.2.1.

5.2.3 Required Facilities The following facilities are required for water distribution:

Conveyance Works	:	Annex C, Tables 1, 2 and 2A; Figures 2,4, through 13, 30, 31
Drainage Works	:	Annex C, Table 3; Figures 3,4, through 13,32
Water Control Structures	:	Annex C, Figures 5 through 13
Farm Roads	:	Annex C, Figures 1, 5 through 13, 33

5.3 Mechanization, Labor Demand and Employment

One of the major concerns in rice production is labor demand. Improper production scheduling can result in exceedingly high peak labor demand, which in turn necessitates mechanization to break the production bottleneck. The introduction of mechanization will not only reduce peak labor demand but it will also reduce overall employment opportunity. The Philippine Government is extremely concerned about employment opportunities in the Bicol River Basin as an avenue to reduce the unbalance in the current income distribution pattern.

A part of the research goal is to determine the extent to which water management can be used to affect labor demand pattern. The effect of land preparation rate on peak is, of course well known, but the length of land preparation period and the rate at which land preparation is to be done, affects the entire irrigation facility design and cannot be easily modified. On the other hand, the effect of other modifications in the production schedule, for example, the number of days allocated for the transplanting operation, has not been explored.

Basically, there are three things that can be controlled in setting up a production schedule: the lengths of the land preparation, transplanting, and harvesting periods. These are the three periods during which high labor peaks generally occur. Lengthening these periods will not reduce the total labor demand, which is a function of mechanization level only, but will reduce the peak demand. From a labor employment point of view, increasing these periods seems to be desirable, however, climate and other production constraints generally favor the shortest possible periods. For example, it is well known that shatter loss of the high-yielding varieties increases rapidly if the rice is not harvested within a day or two. Therefore, only one day is allowed for harvesting with a combine and two days are allowed with no mechanization.

The extension of the transplanting and land preparation periods are compared in Tables 5.2 and 5.3. In Table 5.3, the effect of increased yield is also shown. In Fig. 5.3, it is interesting to note that the peak labor demand occurs at either threshing or transplanting, depending upon the yield. Period extension, however, has a limited range of peak reduction. For example, by extending the land preparation period from 28 to 35 days, the peak labor demand is reduced by 3 percent; when the period is extended to 42 days, the reduction is increased to 5 percent. Also, as Table 5.3 shows, increasing the scheduled time allowance for transplanting, at higher yields with no mechanization, does not reduce the peak labor demand. As a matter of fact, the introduction of a tractor to help with land preparation does not reduce the peak either.

Table 5.2. Comparison of labor demand (L.D.) in irrigated rice production with different land preparation schedules and mechanization alternatives (two crops per year, IR-28)

Mechanization Alternative	Total L.D. man-day/ha	Peak L.D. man-day/ha/day	Average L.D. man-day/ha/day	Estimated Yield kg/ha	Length of land preparation period day
No mechanization	179.5	2.11	0.62	2550	28
Tractor	157.5	2.08	0.55	2550	28
Tractor Mechanical Thresher	127.0	1.95	0.45	2550	28
Tractor Mechanical Thresher Transplanter	107.9	1.29	0.38	2550	28
Tractor Combine Transplanter	91.4	1.29	0.32	2550	28
No mechanization	179.5	2.05	0.60	2550	35
Tractor Mechanical Thresher Transplanter	107.9	2.01	0.37	2550	35
No mechanization	179.5	2.01	0.59	2550	42
Tractor Mechanical Thresher Transplanter	107.9	1.22	0.36	2550	42

NOTE:

Transplanting dates: first crop, mid-January to mid-February; second crop, the month of June.

Land preparation rate, A, was determined from the following equation [7].

$$A = Q[1 - (1-SDt/Ds)^n]\ 8.64*Ec/Dt \text{ ha/day}$$

where: Q = land preparation flow rate (CMS), S = rotational interval (days), n = number of rotational periods in the preparation period, Ds = land soaking water (M), Dt = maintenance water (M/day), Ec = conveyance efficiency.

Table 5.3. The effect of transplanting period on peak labor demand in irrigated rice production, man-day/ha/day

Days for Transplant	No Mechanization	Tractor	Thresher	Tractor & Thresher
	Yield level = 2550 kg/ha			
1	2.35	2.11	2.35	2.11
2	2.26	2.09	2.26	2.07
3	2.19	2.08	2.19	2.02
4	2.11	2.08	2.11	1.95
	Yield level = 3550 kg/ha			
1	2.80	2.80	2.35	2.11
2	2.80	2.80	2.26	2.07
3	2.79	2.79	2.19	2.02
4	2.79	2.79	2.11	1.95
	Yield level = 5800 kg/ha			
1	4.58	4.58	2.35	2.11
2	4.58	4.58	2.26	2.07
3	4.58	4.58	2.19	2.02
4	4.58	4.58	2.11	1.95

NOTE:

Transplanting dates: first crop, mid-January to mid-February; second crop, the month of June.

Land preparation period equals 28 days.

Under normal conditions, when the peak labor demand of an irrigated rice production system exceeds the available supply, it is caused by the high labor requirement for threshing the crop. Therefore, the first step toward mechanization should generally be the introduction of mechanical threshers, farm roads, and other equipment to reduce the labor demand for harvesting, transporting and post-harvest handling of the rice crop.

Figure 5.3 shows the increase in peak labor demand at threshing when there is an increase in yield. Figure 5.4 shows that the maximum divergence from labor uniformity occurs early in the season at low yields and late in the season when the yield increases. Introduction of a mechanical thresher at the lower yield decreases the total labor demand while leaving the peak unchanged, thereby further distorting the labor pattern. When a mechanical thresher is used at high yields the late season peak is reduced and, as Fig. 5.4 shows, the labor distribution becomes very close to that for no mechanization at the lower yield.

With high yields the addition of a mechanical thresher to the production system will reduce the threshing peak below the transplanting peak demand. Table 5.3 shows that the extension of the transplanting period from 1 to 4 days reduces the peak labor demand by about 10 percent, when transplanting causes the peak, without reducing the total labor demand.

The results in Table 5.2 show that the introduction of a mechanical transplanter will cause a greater reduction (about 51 percent) in peak labor demand than in total labor demand (about 18 percent). Also, the small Japanese-type rice combine will reduce the total labor demand but not the peak labor demand, when compared with the mechanical thresher. Figure 5.5 shows the annual labor distribution at 2550 kg/ha yield for several levels of mechanization. All mechanization, with the exception of tractors, distorts the labor distribution pattern more than the no mechanization option.

At the projected 1980 production level, the peak labor demand is approximately 6,000 man-days/day for a rice production system with no mechanization. This represents a peak demand of slightly over 2 men/hectare, which is within the available labor density of the project area (as well as the entire Bicol River Basin). Therefore, unless industrial or other development begins to reduce the labor available, the no mechanization, 4-day-transplant production scheme is recommended. This would greatly simplify the implementation of the project, since farmer education regarding mechanization will not be required immediately. As production increases, threshers and tractor will have to be introduced. A computer program developed to give detailed daily labor and water requirements corresponding to any given rice production schedule can be used in developing guidelines for future policy decisions.

The basic difference between the years 1980 and 2000 is the estimated yields. In 1980 the peak labor demand occurs during transplanting. In the year 2000 both transplanting and harvesting will have become influential in creating peak labor demands. It is of interest to note that with the introduction of threshers, peak labor demand can remain unchanged during the first 20 years of project life.

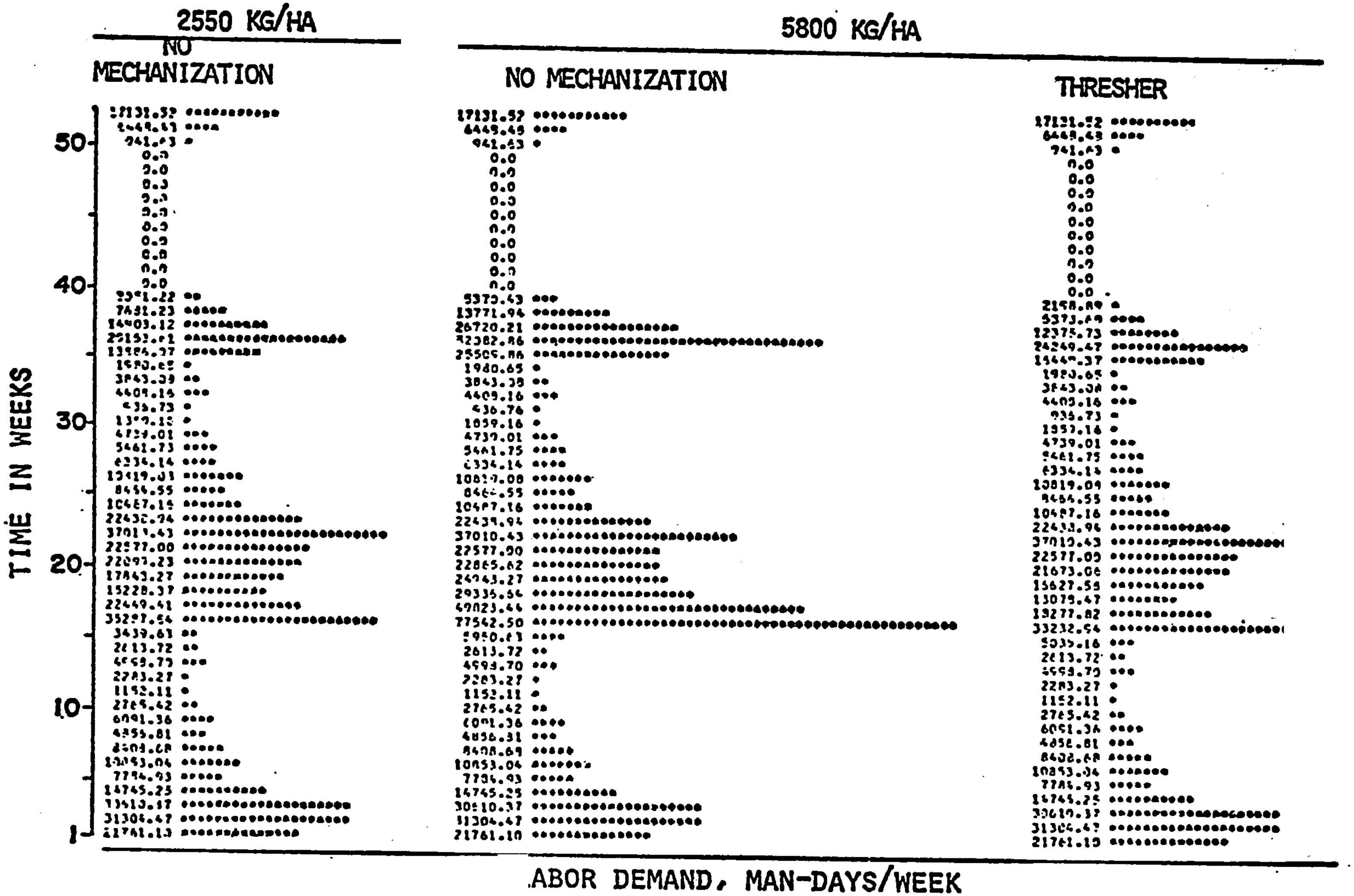


FIG. 5.3. THE EFFECT OF THRESHER INTRODUCTION ON LABOR DEMAND WITH AN INCREASE IN YIELD FOR 2809.23 HECTARES.

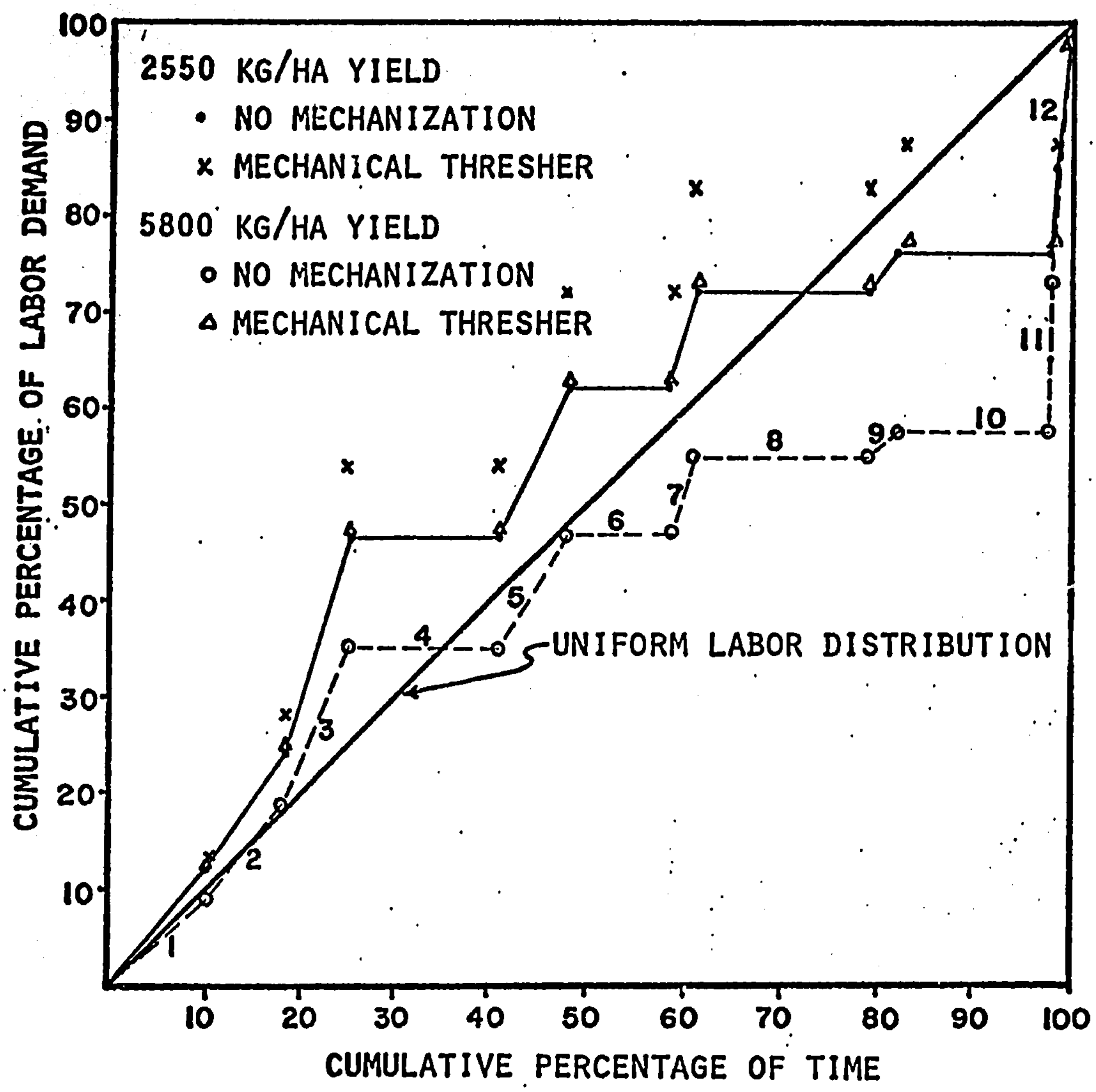


FIG. 5.4. LABOR DISTRIBUTION AT TWO LEVELS OF YIELD, WITH AND WITHOUT THE USE OF A MECHANICAL THRESHER.

NOTE: Links 3, 11 and 12 are transplanting, harvesting, and threshing, respectively.
Links 4, 6, 8, and 10 are growing periods with no labor demand.

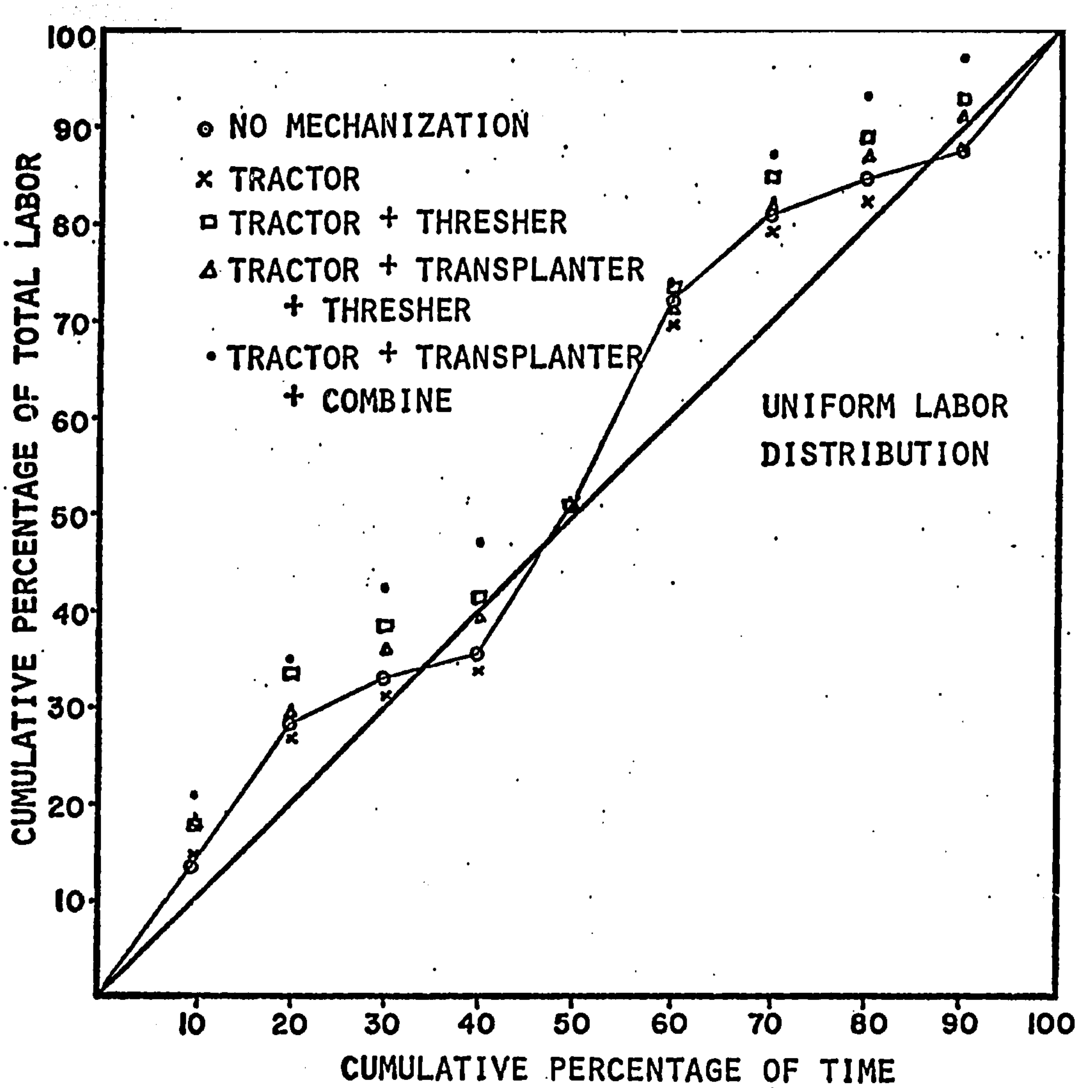


FIG. 5.5. ANNUAL LABOR DISTRIBUTION FOR TWO RICE CROPS AT DIFFERING LEVELS OF MECHANIZATION (2550 KG/HA YIELD)

CHAPTER 6. INVESTMENT COMPONENT 1: ROADS, IRRIGATIONS & DRAINAGE FACILITIES WITHIN PROJECT AREA

6.1 Service Roads

It is difficult to evaluate the benefits that can be derived from service roads. The construction of service roads along primary irrigation and drainage facilities will reduce the construction and maintenance costs of these facilities, and will reduce in-field transportation problems. These two benefits can be reasonably estimated. However, service roads will also greatly enhance other developmental potentials of a project area, and there are other indirect social benefits which are difficult to evaluate. Therefore, in this study service roads are considered a necessary component of the project, and effort has been directed toward establishing economic justification for the required road density.

The BRIS project area is divided into four sections by the concrete surfaced national highway and the asphalt provincial road from Iriga City to Balatan. These roads, totalling about 16.93 km in the project area, are the only all weather roads within the project area.

Presently, there is about 39.31 km of service roads in the project area. Many of these roads need to be improved and upgraded to 5.0 m widths and resurfaced. The existing road density, including the all weather roads, is about 20.0 m/ha.

Proposed for construction are 59.876 km of service roads along lateral and main irrigation, and main drainage canals. This will bring the road density in the project area up to 41.3 m/ha. Most of the proposed feeder roads are to be 4.0 m wide and will connect with the 5.0 m wide Barrio roads.

These feeder roads will generally be limited to canal repair machinery and vehicles used in transporting agricultural supplies and palay. The road is designed to have one lane with 0.25 m for shoulders on each side, the effective width of the road is 3.5 m. The 5.0 m service roads connect the feeder roads to the all weather roads and will handle a large volume of traffic. These are designed as two lane roads with 0.25 m for shoulders on each side, the effective width is 4.5 m.

Table 6.1 Vehicle Traffic on Roads

Vehicle		Width
0.3 m^3	Backhoe	2.8 m
	Bullcart	1.3 m
	Car	2.0 m
4 wheel	Tractor	2.0 m
2 ton	Truck	2.3 m

IRRI has found the average rate for manual transport of palay is 0.6 ton-km per 9-hour day.* The projected yield for IR riceland in the 1976 dry season is 58 cav/ha** and this yield takes the farmer 4.8 man-days/km to transport the palay to a road. In the year 2000 the projected yields are 123 cav/ha and they would take 10.3 man-days/km for transportation. At present large portions of the BRIS are 1 km and further from a feeder or service road. The proposed roads layout is such that all rice paddies are within 500 m of a road. This will reduce the farmers drudgery in transporting his palay from the field to a road thereby contributing to an increase in his quality-of-life. See Annex C for the location of existing and proposed roads and the typical design section.

*IRRI Annual Report 1965, p 283
**TAMS/TAE Report No. IV, March 1976, p 22.

6.2 Irrigation

The design of irrigation facilities is probably the most important component in the planning and designing of an irrigated rice production system. Not only is a large portion of the total capital investment generally devoted to the irrigation facilities, but, to a large extent, the success or failure of the production system depends upon the design of irrigation facilities. Efficient utilization of water and water conveying systems is important in the design of irrigation facilities because water resources are generally limited and construction of irrigation facilities costly. A properly designed irrigation system is vital to the management of the water and cropping schedules, therefore, in designing an irrigation system, the designer must consider the social constraints in the project site so the proposed management scheme will be acceptable to government agencies and the farmers.

Irrigation facilities can be classified into primary conveying systems and in-field distribution facilities. The primary conveying systems consist of the main canals, laterals, and sub-laterals. The in-field distribution facilities are the farm ditches that deliver irrigation water to the paddy fields.

The Barit River Irrigation System has an existing network of primary conveying facilities. The existing system was constructed in the sixties by the Bureau of Public Works. It is now being operated by the National Irrigation Administration. There are about 52.4 km of primary conveying facilities with a very limited amount of in-field distribution facilities constructed by the farmers.

To reduce the project capital investment requirement, new formulae were developed that reduce peak irrigation water demand in the primary system by up to 30%. The reduction in peak irrigation water demand also reduces management problems for BRIS during periods of low flow in the Barit River. A detailed description of design formulae and procedures used can be found in Volume I. A simplified water management scheme, which allows the National Irrigation Administration to retain its management responsibility over the primary delivery system, has also been developed. The proposed water management scheme uses the rotation-by-lateral concept. It requires no change in irrigation schedule throughout the entire cropping season. This simplification allows the farmers to manage the in-field distribution facilities with simple organizations, such as compact farms or small irrigation associations. Futhermore, it allows the gradual transfer of management responsibilities from the National Irrigation Administration to farmer organizations as these organizations become larger in size and more experienced in water management. A 7-day rotational irrigation schedule is proposed throughout the entire cropping season.

It is proposed that the existing irrigation facility be improved by enlarging the existing system where necessary, and by the addition of primary and in-field distribution facilities. A summary of the irrigation facility, after the proposed improvement is completed, is given in Table 6.2. In the layout of the in-field facilities, the ditches are made to follow existing plot boundaries. Maximum effort has been applied to keep the proposed farm ditches under 1 km in length in order to reduce seepage losses in the end reaches. To reduce cross paddy flow problems, farm ditches are laid out such that no paddy field is more than 300 meters from a farm ditch. A detailed description of the proposed irrigation facility can be found in Annex C and the design procedure can be found in Volume I.

Table 6.2 Summary of Proposed Irrigation Facility

	Total Length (km)	Density (m/ha)
1. Main Canal	29.13	10.37
2. Lateral & Sub-lateral	65.56	23.34
3. Farm Ditches	208.38	74.18
4. Main Drainage	68.99	24.56
5. Secondary Drainage	59.40	21.14
Sum of 1, 2, 3	303.07	107.88
Sum of 4, 5	128.39	45.70

One of the most interesting problems in this study is the evaluation of the in-field distribution system design. The importance of in-field water distribution to the successful development of an irrigated rice production system is well recognized. Nevertheless, it is very difficult to quantify this importance. There is no way, for example, for a designer to show that a 10% reduction in farm ditch densities will bring about at least an equal amount of reduction in project benefit. This is because basically the farm ditches are tools of management. The primary irrigation facilities have already brought irrigation water close to the paddy field and farm ditches merely facilitate the evenly and timely distribution of irrigation water. A strong and efficient farmers organization may, at times, reduce the need for farm ditches. On the other hand, it is well known that the existence of well laid out farm ditches helps the development of farmers organizations. More often than not, when there is a lack of farm ditches, the first job a farmers organization will do is to develop such facilities. Uneven and untimely distribution of irrigation water caused by cross paddy flow can cause serious problems for any irrigated rice production system. Therefore, the basic guideline used by the University of Hawaii research team in its design of an in-field irrigation water distribution system is socially based. In other words, the degree of cooperation likely to be obtained is first assessed, and the basic requirement of the 7-day rotational schedule is also used to establish our design criteria that no paddy field should be more than 300 meters from a farm ditch.

6.3 Drainage

Drainage system design is based on the procedures discussed in Volume I. The basic criteria is to discharge excess water to keep the water level in the paddy rice to a depth not to exceed 20 cm for a period not to exceed 3 days during the critical rice growth stage. Examination of the proposed crop schedule and seasonal rainfall distribution around the project area indicates that the critical period for drainage design is from the first of December to the end of March. Due to a lack of adequate rainfall data recorded within the project area, rainfall records at the Buhi weather station, divided by a factor of 1.3 (see Chapter 3, Section 2) were used in the drainage system design of BRIS. Frequency analysis of 3-day rainfalls at Buhi from December 1 to March 31 showed the expected rainfalls of 5, 7 and 10 years return period are 251.756 mm, 282.293 mm and 318.718 mm, respectively. The rainfall intensities for these return periods at the project area were estimated to be 2.69 mm/hr, 3.02 mm/hr and 3.41 mm/hr respectively, after converting the total rainfall volume into volume per unit time and dividing by 1.3. Following the procedures discussed in Volume I, the required bund opening for rainfalls of 5, 7 and 10 years return period are 0.36 m/ha, 0.41 m/ha and 0.46 m/ha respectively. The drainage ditch design discharge capacities are tabulated in Annex C. A 10% safety factor has been used for the downstream portion of the main ditches. Layout of the drainage ditches is included in Annex C.

CHAPTER 7. INVESTMENT COMPONENT 2: DRAINAGE TO BICOL RIVER

As described in Chapter 3, Section 2, surface runoff from the project area mostly drains into the Barit and Waras Rivers which in turn drain into adjacent water-logged areas. An adequate drainage system in the paddy field alone will not resolve the drainage problems in the project area. The rivers receiving water from the project area must be dredged to increase their present discharge capacities and the downstream water-logged areas must also have sufficient storage and/or outlet capacity to handle the inflows. To service the proposed drainage system for the BRIS project, both the Barit and Waras Rivers have to be cleaned and maintained regularly so their designed return period peak flows, as listed in Chapter 3, Section 2, will not cause flood damage to the fields along the rivers. In addition, some measurements have to be taken to improve the flooding situation of the water-logged areas. One possible scheme proposed by TAMS/TAE* is shown in Figure 7.1.

A detailed design and analysis of the excavation work on the Barit and Waras Rivers cannot be undertaken at this time because the totality of the problem cannot be analyzed by considering the drainage requirement of the BRIS project alone. The external drainage channel as proposed in the comprehensive water resources study conducted by TAMS/TAE will benefit not only the project area but will also reclaim the water-logged area.

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*Dejarnett, H.B. and Vetter, R.R., Prefeasibility Cost Estimates of Compreshensive Water Resources Development Plan - Bicol River Basin. TAMS/TAE XXI, CWRD Study, Naga City, June 1976.

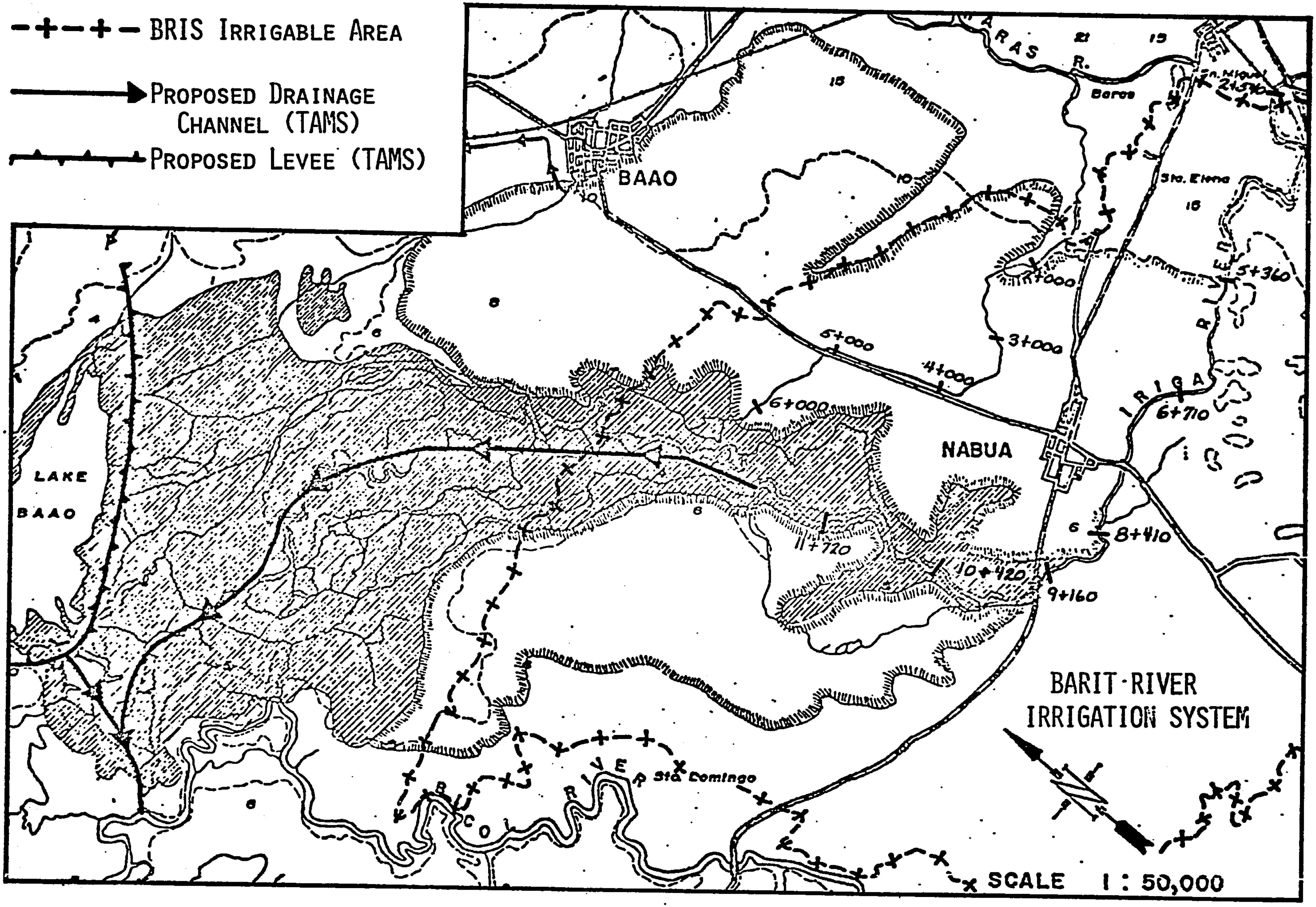

FIGURE 7.1. EXTERNAL DRAINAGE FOR BARIT RIVER IRRIGATION SYSTEM.

CHAPTER 8. INVESTMENT COMPONENT 3: INCREASE STORAGE & REGULATION OF LAKE BUHI

During some years the Barit River may not have sufficient flow to supply the water requirement for the growing of two rice crops per year if the recommended cropping schedule is to be followed. The deficit in flow may occur during the land preparation period of the wet season crop, April to May, and may again occur in the middle of the growth season when maintenance water is required.

During the years 1954-1966, the lowest flow on record of the Barit River was 1.2 cms, which occurred in May 1963. Land soaking for the wet season rice crop is scheduled for the period from 22 April to 20 May. The maximum deficiency in water supply for the entire 28-day period may be as high as 9.8 million m^3.

During the maintenance water period, 21 May to 15 August, the stream flow can drop below the 4.878 cms needed, for as long as 20 days. A flow of 1.4 cms occurred in late June and early July of 1966 and again in 1968. The maximum water deficiency during the growth season is estimated to be about 6 million m^3. Calculations of maximum possible water deficiency for the wet season rice crop are as follows.

Using a rice variety that matures in 105 days from sowing, and transplanted at 13 days, a total of 121 days is required for a complete production cycle.

A total of about 2810 hectares are to be irrigated in the BRIS project area. Using a land soaking and preparation water requirement of 0.13 m and a maintenance water requirement of 0.009 m/day with an overall system water conveyance efficiency of 60%, the improved formulae indicates that a constant flow rate of 5.245 cms is required for land preparation. In other words, a total of approximately 12.7 million cubic meters of water is reqired for the 28-day period during which land preparation is scheduled.

There are 70 days from the time rice is transplanted until water is cut off on the 98th day of the production cycle, or 23 days before harvest. The actual cut-off date may be moved forward somewhat, depending upon weather conditions, however, for the purpose of estimating water requirement 23 days was chosen. At 0.009 m/day, 4.878 cms is required for maintenance water to compensate for evapotranspiration and seepage losses. In other words, a total of 29.5 million cubic meters of water are required for the 70-day period.

Total water requirement for a single crop of rice is estimated to be 42.2 million cubic meters for the BRIS project area, or approximately 15,000 cubic meters of water per hectare.

Since the minimum stream flow record of the Barit River is only 1.2 cms in May, in order to insure water availability at all times, an additional 4.049 cms may have to be drawn from storage sources during the 28-day land preparation period. The record of minimum Barit flow is 1.4 cms during the maintenance period and this low flow may last as long as 20 days during the months of May-August, an additional 3.478 cms may have to be drawn from the proposed Lake Buhi storage. Using an estimated effective rainfall* of 6.4 million cubic meters, the total maximum anticipated water deficit is

$$4.049 \text{ cms} \times 28 \text{ days} \times 24 \text{ hr/day} \times 3600 \text{ sec/hr} \simeq 9.8 \times 10^6 \text{ m}^3$$

$$3.478 \text{ cms} \times 20 \text{ days} \times 24 \text{ hr/day} \times 3600 \text{ sec/hr} \simeq 6 \times 10^6 \text{ m}^3$$

$$\text{Maximum Anticipated Water Deficit} = (9.8+6-6.4) \times 10^6 \text{ m}^3$$

$$= 9.4 \times 10^6 \text{ m}^3$$

The TAMS consultants estimate the surface area of Lake Buhi to be 18 square kilometers (18,000,000 m^2). Cumulative evaporation from Lake Buhi exceeds rainfall for January through June by 581.75 mm, or approximately 10.5 x 10^6 m^3.** Adding the evaporation loss to the maximum anticipated water deficit gives the total storage requirement of 19.9 million cubic meters.***

The annual fluctuation of the lake is estimated to be 1 to 2 meters. Development of a regulatory capability, within annual lake fluctuation levels, would ensure the availability of water for two paddy rice crops annually.

It should be made clear that the storage requirement of 19.9 million cubic meters is based upon a 22-year low flow record. Since record low flows during the two periods generally do not occur in the same year, this estimated storage requirement of Lake Buhi represents a safe approach to the problem. No further design analysis, which would lead to an economic level of storage requirement, has been done because it is expected that the Lake Buhi storage capacity will be required by not only the BRIS but also other irrigation facilities. Therefore, a detailed analysis of optimal storage capacities for Lake Buhi based solely on the BRIS requirement would not be a very useful exercise at this time.

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*Effective rainfall is based upon the five driest consecutive years of record, 1966-1965. The rainfall record, 1950-1969 and 1971-1975, for Lake Buhi was used.

**Evaporation data is a 6-year average from Yabo Farms, Naga City. The estimated pan to lake coefficient is 0.69.

***With effective rainfall.

CHAPTER 9. FARMERS ORGANIZATION AND TRAINING

With due consideration to the implementing line-agencies development strategy, it is planned to initially transfer the operation of terminal irrigation units to the water users and then ultimately to delegate responsibility for operation and maintenance of the entire system to a system wide irrigators' association. Transference of system wide responsibilities will be made as soon as an organization of water users is formed and is capable of operating and maintaining the system. Several steps should be undertaken preparatory to accomplishing these objectives.

To ensure smooth project implementation, the initial focus will be on the training of a team of prospective implementors, and these trained personnel will in turn train farmer-beneficiaries. Having completed the intensive training program for the project implementors, organization of compact farms will follow with a corresponding training program, after which, the irrigators association will be formed. Continuing extension support services and other forms of assistance will be provided by the government to the farmer-beneficiaries.

9.1 Training

The training program for project implementors will primarily focus on the operation and maintenance of irrigation and drainage systems, on crops and livestock production, on management, and on other areas such as cooperatives development and agrarian reform program. Similarly, the coverage of the training program for the compact farm coordinators will revolve on the same topics with some modification in the approach, while the ditchtenders will be trained on the efficient distribution of irrigation water to the compact farm members.

9.1.1 Project Component Implementors (PCI) Although the prospective project implementors are expected to be knowledgeable in their lines of specializations, an intensive training program for them will be designed and conducted. Since team approach will be adopted, the training program will provide knowledge and insights on interrelated activities of the project. Each member will be transformed into a generalist so that immediate response to inquiries from beneficiaries can be given in a way to build farmers confidence in the project implementors. The training program will revolve on the operation and maintenance of the irrigation and drainage system, on crop and livestock production, and on management.

On the operation and maintenance of the irrigation and drainage system, emphasis will be focused on water distribution above and below the turnout. Skills will be developed in interpreting historical water flow data to anticipate future occurrences and setting objectives for each season, and farming alternatives to be followed should expectations fail to materialize; regulating, controlling and measuring water discharge, and in collecting and interpreting data throughout the system; guiding O & M personnel on distribution scheduling, in conjunction with the irrigators association officers; training water users in relating discharges, time and area irrigated, to attain more economical water use; and encouraging farmers involvement in the operation and maintenance of the system.

Since the project is designed mainly for rice production, its technical and management aspects will be emphaized. Other crops which are usually grown by beneficiaries in their backyards will also be given due attention. Livestock and/or poultry production training may also be included since farmers in the area are also engaged in such enterprises.

Since the system proposed for the area will eventually be managed by an irrigators' association, the universality of the management process and its application to irrigation systems will likewise be given much emphasis in the training program.

Other areas of study, which may be deemed necessary, such as a Land Reform Program, will also be included. Both classroom and on-the-job training techniques will be used.

9.1.2 <u>Compact Farm Coordinators and Ditchtenders</u> The coverage of the training program for the compact farm coordinators and ditchtenders will be similar to that of project implementors' training program, although some modification will be made to suit the understanding ability and areas of interest of the farmers.

A group of thirty-five to forty participants will be accommodated in two-week training sessions; one week for classroom discussion and one week on-the-job training will be held in the project area.

9.2 <u>Organization</u>

9.2.1 <u>Compact Farms</u> Despite the massive efforts and investments by the Philippine government in the past, a breakthrough in agricultural production has not yet been realized due to the slow adoption of modern farm technology by the farmers. This might be influenced by the prevalence of hazards and crop failures, availability of input factors, and profitability. Other factors of utmost significance are the farmers perception of innovation, cooperation, and education.

With the very limited number of government extension personnel and implementors of development programs in general, personalized attention to the individual farmer is quite impossible. Therefore, strategies must be developed to hasten dissemination of information and government assistance while at the same time utilizing resources more efficiently. In the most recent development projects being implemented in the Philippines, farmers were organized into basic production units, "Compact Farm", to facilitate education on better farming technology and to receive other forms of government assistance. Each compact farm elects a coordinator and a ditch-tender from the members.

The compact farm, as conceptualized and adopted by the BRBDP, is a sub-unit within larger on-going societies which are the "Samahang Nayons" Composed of 8 to 10 members, a compact farm is a production-oriented farm level group, members of which are cultivating contiguous farm holdings within a rotational unit. Specifically, the operations of compact farms are guided by the following principles:

- In order to attain maximum utilization of limited resources and encourage cooperation among members; all compact farm operations and activities will be coordinated by an elected compact farm coordinator. For individual farms, farm planning and budgeting may be prepared separately.
- Jointly and severally liable policy for the financing of compact farms secured by members from any lending institution will be strictly followed by members.
- To ensure loan repayment and fair prices for the produce, there will be controlled marketing of the products, especially the pledges.
- Adoption of superior farm technology will be observed by all the compact farm members.

In terms of water management, the compact farms coordinators shall be responsible for coordinating the efficient distribution of irrigation water among compact farm members within the rotational unit. The assistance of Water Management Technologists and other systems personnel will be available to help prepare individual farmer water delivery schedules. The ditchtenders, on the other hand, shall be in-charge of the actual water distribution. Maintenance of facilities and structures within the rotational unit will be the responsibility of the compact farms.

9.2.2 Irrigators Association From the farm level aggregation of farmers, another level of farm organization, the Irrigators Association, can be formed. The Irrigators Association will be the body to administer the irrigation system in the future, allowing NIA to move to other locations where its' services are badly needed. It is important for a successful transfer of the operation and maintenance of the system, to have an immediate formation of the organization. This will allow the members to be involved in the planning, construction and operation of the project thereby gaining knowledge and experience. In the beginning, system management will be undertaken by a contracted professional group allowing the farmers to develop their management capabilities. The contracted professional management group will be required to post a performance bond to ensure proper operation and maintenance of the system. Furthermore, conflicts that may arise due to the subjective decisions of farmer members will be entirely separated from the objective decisions of the management.

a. Composition

The association is required by NIA to register with the Securities and Exchange Commission like any other business organization. It will be run by a five-member Board of Directors and officers elected from the general membership. Special committees such as finance, grievance, education and promotion, water distribution and maintenance, and production will be formed. The committee chairmen and members will be elected by the members of the Board and officers.

b. Compensation

The Board of Directors, officers, and committee chairmen will be actively involved in coordinating the operation of the system and controlling the activities of the contracted professional management group. Because this may mean sacrificing some work on their own farms, material incentives will be provided. A minimum salary of ₱ 240.00 per month will be allocated to each of them.

c. Responsibilities and Obligations

The association will be fully responsible for administering the operation and maintenance of the transferred irrigation system. Collection of water fees and payment of amortization for the governments' investment will be undertaken and shouldered by the association. In other words, the association will assume, upon transfer, all the tasks currently performed by the system personnel, with minimal governmental supervision.

9.3 Extension Support Services

Aside from the team of implementors, line-agency personnel assigned in the area will be harnessed to intensify extension support services. This will also improve the coordination of efforts in the project area avoiding conflicts and duplication of activities.

After the administration of the system is degegated to the irrigators association, although it can be assumed that the members are technically and managerially capable to handle the project on their own, continuing extension support services and other forms of assistance should be given to the project beneficiaries. This is to sustain the development process in the area.

9.4 Strategy of Implementation

At the start of the project, a foreign consultant will be recruited to review the plans prepared by a team of project implementors and to formulate procedures for transferring the responsibility for running the system to an irrigators association to be formed in the course of the project implementation. An intensive training program for both the implementing team and the leaders of the organized operationalized compact farms will be conducted preparatory to the systems turn-over. When the water users are equipped with the necessary capabilities, the irrigators association will be organized to effect the formal transfer.

9.4.1 Recruitment of Consultant It is the strategy of the National Irrigation Administration to transfer the responsibility of operating and maintaining its constructed irrigation systems to the irrigators association when its members have developed the capability to run the system. However, no standardized procedure has been developed to effect the transfer of irrigation projects planned and constructed by the government. As a matter of fact, although more and more irrigators associations have been organized, no government constructed irrigation project has been totally transferred at this time, therefore, there is no data available for an analysis of an irrigators' association's actual management, neither is there data available on its impact on the efficiency of the operation and maintenance of the system.

Rotational irrigation systems with intricate on-farm terminal distribution facilities, call for a knowledgeable and capable irrigators association to handle the system. Necessary steps for a successful transfer should be undertaken under the guidance of those who have experience in such type work. No local expertise, however, is on hand. It is proposed, therefore, that a foreign consultant be recruited at the start of the project implementation and be retained for about three months.

Preliminary plans for the project components will be prepared by a team of project implementors to be organized specifically for the project. The consultant will review these plans and help formulate procedures, adaptable to local conditions, for transfering facilities from construction to operation and maintenance status.

9.4.2. Organization of Project Component Implementors (PCI) The National Irrigation Administration, the lead agency, with the close coordination of the BRBDP will organize a team of project implementors from the different participating line-agencies. A memorandum of agreement, by and between the Program Director of the BRBDP and the heads of the agencies concerned, regarding the full-time detail of personnel to the project until such time that their services are no longer needed, will be executed.

Additional personnel will be hired for the team to act as Water Management Technologists (WMT). A WMT should have a bachelors degree in Agriculture or Civil or Agricultural Engineering; persons with a two-year degree in Agriculture and long experience in water management also qualify.

An Irrigation Engineer from NIA will act as the Team Leader, the Municipal Development Officer for Nabua from DUGCD will be the Assistant Team Leader. They will be responsible for coordinating the team activities. The team shall also coordinate and work closely with other personnel employed by line-agencies and other institutions. Likewise, the services of the consultant will be available to the team.

9.4.3 Training Program for PCI Preparation of the training design and materials will be undertaken by Training Specialists from various cooperating line agencies with the coordinative efforts and participation of the BRBDP Training Specialist. Utilizing existing dormitory and classroom facilities, the classroom training will have a duration of two months. Authorities on topics incorporated in the training program will be invited as speakers. Immediately after the classroom training, the team will be exposed to on-going projects in various parts of the country to gain additional knowledge and insight into other projects experiences which may be applicable to the project area.

All necessary arrangements for the training program will be undertaken by this group of training specialists wherein a Training Coordinator will be designated by NIA to manage the training program.

The conduct of the training program, to be held either at the NIA or BRBDP training centers, will be under the direct management of the Training Coordinator. Administrative, clerical, and logistic support will be provided Allowances for both participants and training staff will be allocated.

9.4.4 <u>Organization of Compact Farms (CF)</u> Immediately after the trainin program of the PCI, the team will organize and/or operationalize new and existing compact farms respectively, based on the BRBDP compact farming concept.

Due to the transportation constraints in the area, each member of the PCI schould be provided a motorcycle to facilitate their organizational activities.

9.4.5 <u>Training for CF Coordinators and Ditchtenders</u> The Training Coordinator of the PCI training program together with the members of the PCI will prepare the proposed training program for the CF coordinators and the ditchtenders. The proposed training program should seek to develop the managerial and operational capabilities of the compact farm coordinators, and training the ditchtenders in efficient distribution of irrigation water to the farmer-members of each compact farming unit. Materials to be utilized should be easily understood by the clientele. If possible, the dialect spoken in the area should be used.

Having completed the above, the PCI Team Leader shall designate a Training Coordinator from the members of the PCI who will be responsible for conducting the training program. The other members of the team will be actively organizing compact farms and acting as resource speakers.

9.4.6. <u>Organization of Irrigators Association (IA)</u>

a. <u>Pre-Organizational Level</u> Since the organization cannot function immediately in a business-like manner, but it is of absolute necessity to immediately organize the water users in order for them to be involved and know the intricacies of the development process, a pre-organizational level association will be formed which may be termed an "Irrigators Group." Its operation will be governed by a constitution and By-laws to be prepared by the leaders of the existing associations with the assistance of the PCI and approved by a majority of the water users. This mechanism provide the group on-the-job training that will allow them to acquire the needed skills in the actual management of the system. Thus, the composition of the group will be similar to that of the proposed formal organization mentioned earlier. The group will work closely with PCI and other government line-agency personnel involved in the project.

This pre-organizational level transitional period will result in a smooth transfer of responsibilities as formulated with the supervision and advice of the foreign consultant. It will provide a time to test and mature project structures and facilities, and to solve problems which generally develop during the early irrigation phase. Intensive on-the-job training can also be undertaken to assure project success. Furthermore, the water users will be partially relieved of the financial burden because water fees will not be charged to water users whose farms are within areas on test-run for a period of one year.

Planners of the Libmanan-Cabusao Integrated Area Development Project, 3,373 hectares with a scheduled construction period of three years, estimated to turn-over management of the irrigation system to the irrigators association a year after completion of construction. However, foreign country experience, notably the 20,000 hectare East Bench Irrigation Project in Montana, U.S.A., took the Bureau of Reclamation, whose policy is to transfer operation and maintenance of projects to a water users organization, twelve years after construction to effect complete transfer. This may mean 1,683 hectares yearly because if the construction is extended over several years, segments of the project are transferred as soon as appropriate.

Based on this information, the turn-over of the Barit River Irrigation System to the irrigators association should take effect not earlier than two years after construction is completed.

b. Organization Level With the managerial capabilities acquired by the water users through intensive training and operation experience, the system can finally be turned over to the irrigators association. Operation will be undertaken like other business organization. The "Irrigators Group" will then be dissolved.

Prior to the organization of the irrigators association, a pre-organizational meeting, to be participated in by the CF coordinators, and Board of Directors and officers of the defunct, "Irrigators Group," will be called by the PCI, with hired legal services, to draft the Articles of Incorporation for the proposed association to be approved by a majority of the water users. With approval of the Articles of Incorporation, another meeting will be held to formally organize the association. To comply with a NIA requirement, the association will be registered with the Securities and Exchange Commission.

1. Collection and Use of Water Fees

The Association's main source of funds will come from the collected water fees as authorized by NIA. Assuming no natural calamities occur, and with eighty per cent collection efficiency, the association can collect a total of ______________ cavans of palay or ____________ annually.

The collected water fees shall be utilized for the operation and maintenance of the system, improvement of physical facilities, amortization of the government's investment in constructing the system, and payment of overhead expenses. The cash flow is shown in Annex "A".

2. Operation and Maintenance

The operation and maintenance of the system will be contracted to a professional group. The contractor shall be qualified and given a contract covering services for operations and maintenance of the whole system.

To ensure quality of service, a NIA person should be a member of the bidding committee.

9.4.7 <u>Examination of Operation and Maintenance Program</u> Aside from the task of monitoring the implementation progress of on-going development projects, the PMD is empowered to exercise control over completed development projects to know whether the project operations are conforming to the planned activities and targeted goals.

This development project is no exception. Its operation and maintenance program will be subjected to periodic examinations by the PMD to inspect project works, make recommendations for improving maintenance, correct conditions which are not normal, discuss the current operation and maintenance program, and review recommendations made in the past.

The PMD Deputy Director will form a team from the PMD Staff and participating line-agency personnel to periodically examine the project; composition of the team may be altered from time to time at the discreetion of the Deputy Director. The Board of Directors and/or officers of the Irrigators Association and the Manager of the contracted Professional Operation and Maintenance Group may be invited to attend a briefing program on the scope of the examination. This examination will primarily be directed to the condition and functioning of irrigation facilities; structures, ditches, and canals, and problems such as bank erosion, silting and flooding. It will also include operation and maintenance practices. The examiners will also take note of equipment, water records, water delivery problems, and records of accounts.

The Board of Directors and/or officers of the Irrigators Association, and Manager of the Professional O & M Group will be encouraged to participate in the examinations. After each examination trip, a meeting will be held to discuss new recommendations and to assure that there are no misunderstandings amoung the participants.

Before the examination report final draft is prepared by the team of examiners, copies of the first draft will be forwarded to the Board of Directors and/or officers of the Irrigators Association and Manager of the Professional O & M Group for comments and further suggestions, after which, the final report will be printed and distributed to the concerned and interested parties.

Table 9.1 Implementation Schedule/Target, Farmers Organization and Training, BRIS Project

ACTIVITY/GOAL	YEAR 1												YEAR 2												YEAR 3 to 4						YEAR 5					
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	.	.	12	1	2	3	.	.	12
A. Recruitment of Consultant																																				
a. No. of consultant		1																																		
B. Organization of PCI																																				
a. No. of Team Members	7																																			
C. Preparation of PCI Training Design and materials	—																																			
D. Training of PCI																																				
a. No. of participants			7																																	
E. Preparation for CF organization					—																															
F. Organization/Operationalization of CF's																																				
a. No. of CF's						14	44	44	44	44	44	44	44	44	44	44	44	44	44	44																
G. Preparation of CF Coordinators and Ditchtenders Training design and materials							—																													
H. CF Coordinators Ditchtenders Training																																				
a. No. of sessions								2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2													
I. Organization of Irrigators Group																																				
J. Irrigators Group on-the-job Training																																				
K. Organization of Irrigators Association and Turn-over of Irrigation System																																				

Table 9.2 Personnel Requirement, Farmers Organization and Training, BRIS Project.

Number	POSITION	AGENCY/ Hired	TITLE
1	Irrigation Engineer	NIA	Team Leader
1	Municipal Development Officer (For Nabua)	DLGCD	Asst. Team Leader
2	Municipal Development Officers (For Baao and Iriga)	DLGCD	Member
1	Crops Production Specialist	BPI	Member
1	Livestock Production Specialist	BAI	Member
1	Extension/Training Specialist	BAEx	Member
4	Water Management Technologist	Hired	Member
2	Clerk/Typists	Hired	Clerk/Typists

Table 9.3 Budgetary Requirement (₱000), Farmers Organization and Training, BRIS Project

ITEM	YEAR 1	2	3	4	5	TOTAL
A. Personal Services						
a. Consultant's Fee	22.7	-	-	-	-	22.7
b. Incentive Allowance 1/	26.1	26.1	26.1	26.1	26.1	130.5
c. Training Allowance 2/	161.3	564.0	-	-	-	725.3
d. Salaries/Wages 3/	42.0	42.0	42.0	42.0	42.0	210.0
e. Fixed Charges 4/	4.0	4.0	4.0	4.0	4.0	20.0
B. Capital Outlay 5/	68.5	-	-	-	-	68.5
C. Supplies and materials	6.0	5.0	5.0	5.0	5.0	26.0
D. POL Products	26.4	26.4	26.4	26.4	26.4	132.0
E. Sundries	4.0	4.0	4.0	4.0	4.0	20.0
F. Contingency 6/	54.2	100.7	16.1	16.1	16.1	203.2
TOTAL	415.2	772.2	123.6	123.6	123.6	1558.2

1/ ₱350.00 montly for Team Leader, ₱325.00 for Asst. Team Leader and ₱300.00 monthly each for member (For agency-detailed personnel)

2/ Allowance for staff, participants, and resource speakers

3/ Four (4) Water Management Technologists @₱700.00 monthly and Two (2) clerk/typist @₱350.00 monthly

4/ 9.5% of salaries and wages

5/ Eleven (11) motorcycles at ₱5,000.00
Eleven (11) office tables @ ₱300.00
Thirteen (13) office chairs @ ₱100.00
Two typing tables @ ₱200.00
Two (2) Typewriters @ ₱4,000.00
One (1) Filing cabinet @ ₱500.00

6/ 15% of Items A to E

CHAPTER 10. TENURAL DEVELOPMENT

10.1 Background

The Philippines has had in effect since 1963 a Code of Agrarian Reform with three general thrusts; resettlement of farmers from crowded areas to remote public lands; regulation of landlord-tenant relation; and expropriation of landed estates for ownership transfer to tenant-farmers. Secondary elements have included increased sources of institutional credit, some of it is supervised and tied to improvements in technology. This code is still the law of the land and its implementation is proceeding, though there are widely differing views as to its relative success and/or failure. It has been largely overshadowed by Presidential Decree No. 27, February 28, 1975, which began the more fundamental reform, converting tenants on rice and corn lands to amortizing-owners. Under this decree, a total of 40,780 rice/corn farmers in Camarines Sur have been identified and about fifty-three per cent are projected to be converted to amortizing-owners while the rest will be under leasehold. This target deviates significantly from the national and regional projection of thirty-seven per cent in Operation Land Transfer and sixty-three per cent in leasehold. Furthermore, it is noted that only 8,662 farmers in Camarines Sur have been awarded Certificates of Land Transfer, however, the Department of Agrarian Reform is speeding-up its activities so the bulk of the recepients can receive their certificates.

In the project area, most farmers are owner-cultivators. However, a significant portion of the farmers (39%) are share tenants and leasees. See Table 10.1.

Table 10.1 Farm Tenural Situation, BRIS Area, 1975

TENURE	NUMBER	PERCENT
Owner-cultivator	3,844	61.04
Tenant-tiller	2,295	36.44
Leasee	139	2.22
Others	19	0.30
TOTAL	6,297	100.00

The pace of tenural development in the project area is much slower than that for the entire province. About sixty per cent of the share tenants in the province have been converted to leasehold compared with about six per cent in the project area. See Table 10.2

Table 10.2
Operation Leasehold Status in Camarines Sur & Project Area

LEVEL	Tenant-tiller converted to Leasehold		Tenant-tiller not yet converted		TOTAL	
	NO.	%	NO.	%	NO.	%
Provincial	11,468	59.6	7,805	40.4	19,273	100
Project Area	139	5.7	2,295	94.3	2,434	100

10.2 The Project Component

Presidential Decree No. 474, signed by the President in October, 1976, includes areas having less than seven hectares of land planted to rice and corn in Operation Land Transfer. This project will benefit about 2,434 farmer-tillers in the project by converting them to amortizing-owners. The land transfer operation will include tenant-tiller and landlord identification, parcellary surveys, and award of land transfer certificates, appraisal of land value, and titling.

10.3 Strategy of Implementation

The Department of Agrarian Reform (DAR), the lead agency for this particular project component, will organize a team to be called the "Tenural Development Team" (TDT). Members of the team will mostly come from identified line-agencies and institutions. To augment personnel capability, five additional Agrarian Reform Technologist and one Statistician will be directly hired in addition to the administrative/clerical staff. Two jeeps will be provided by the BRBDP to ensure team mobility.

The DAR will detail one Senior Agrarian Reform Technologists to act as Team Leader and one Legal Officer for Assistant Team Leader. The Bureau of Lands (BL) will deploy ten personnel for parcellary mapping and land title surveying. Also, there will be one Land Bank representative to handle land payment schemes.

The team will be responsible for executing all project component activities under the direct supervision of the Team Leader. All needed materials will be prepared by the team in addition to making arrangements for "priority processing" of project OLT data by the National Computer Center, Camp Aguinaldo, Quezon City.

The BRBDP Program Director and heads of the participating line-agencies and institutions will sign a memorandum of agreement regarding the full-time detail of their respective personnel to the project during its implementation.

Table 10.3
Personnel Requirement, Land Tenure Development, BRIS Project

NUMBER	POSITION	AGENCY/ HIRED	TITLE
1	Sr. Agrarian Reform Technologist	DAR	Team Leader
1	Legal Officer	DAR	Assistant Team Leader
1	Representative	LB	Member
10	Land Surveryors	BL	Member
5	Agrarian Reform Technologist	Hired	Member
1	Statistician	Hired	Member
2	Clerk/Typist	Hired	Clerk/Typist
2	Driver	Hired	Driver

Before fielding the team, an orientation workshop and/or training program lasting about one month should be conducted by the DAR in coordination with the BRBDP. The orientation will cover the steps and interrelated activities in the execution of the Land Reform Program. Since the project operations will entail a great deal of work with farmers and landlords, topics on human relations should be covered.

To avoid conflicts and misunderstandings, the team members should coordinate closely among themselves and other project component personnel.

Table 10.4 shows the project implementation schedule. Table 10.5 describes the annual budget requirements to pay the personnel and other costs associated with this component.

Table 10.4 Implementation Schedule, Land Tenural Development, BRIS Project

ACTIVITY	F Year 1 1978-1979	F Year 2 1979-1980	F Year 3 1980
A. Organization of TDT	(3 months) - July to Sept., 1978		
B. Orientation/Workshop and/or Training	(1 month) - Oct., 1978		
C. Preparation for Tenural Assessment	(1 month) - Nov., 1978		
D. Tenant-tiller/Landlord Identification	(6 months) - Dec.,1978 to May, 1979		
E. Issuance of Certificates of Land Transfers		(6 months) - June to Dec., 1979	
F. Preparation of Lnad Payment Plans		(6 months) - Jan. to June, 1980	
G. Final Land Survey (Pre-titling)		(5 months) - March to July, 1980	
H. Issuance of Emancipation Patents			(6 months) - July to Dec., 1980

Table 10.5 Budgetary Estimate, Land Tenural Development, BRIS Project

ITEM	Year 1	Year 2	Year 3	TOTAL
A. Personal Services				
1. Salaries/wages[1/]	44.1	58.8	19.6	122.5
2. Fixed Charges[2/]	4.2	5.6	1.9	11.7
3. Allowances[3/]	51.8	47.7	15.9	115.4
B. Travelling Expenses	8.0	8.0	2.0	18.0
C. Supplies and Materials	10.0	8.0	2.0	20.0
D. Capital Outlay[4/]	12.7	-	-	12.7
E. POL Products	9.0	12.0	4.0	25.0
F. Sundries	4.0	4.0	4.0	12.0
G. Contingency	21.6	21.6	7.0	50.2
TOTAL	165.4	165.7	53.4	384.5

[1/] ₱600.00 monthly for Agrarian Reform Technologists and Statistician, ₱350.00 monthly for clerk/typist and ₱300.00 monthly for driver.

[2/] 9.5% of salaries/wages

[3/] Incentive allowance at ₱350.00 monthly for Team Leader, ₱325.00 monthly for Assistant Team Leader, ₱300.00 monthly for member; and training allowance for staff and participant.

[4/] Two (2) Typewriters @ ₱4,000.00 One (1) Filing Cabinet @ ₱500.00
Two (2) Typing tables @ ₱200.00 Eleven (11) chairs @ ₱100.00
Nine (9) office tables @ ₱300.00

CHAPTER 11. ECONOMIC EVALUATION

11.1 General Description

Traditional "internal rate of return", "benefit-cost", and "net present value", measures have been used to examine the economic feasibility of the proposed investments. These measures compare the value of the economic benefits which directly result from the proposed investment with the costs of producing these benefits which are directly associated with the project. A project is deemed to be economically feasible if the amortized benefits exceed the amortized costs.

The economic analysis relates only to the economic benefits and costs from the standpoint of the society as a whole. That is, the expected costs and revenues have been adjusted, to the extent possible, to eliminate price distortions which occur as a result of taxes and the value of transfer payments which are frequently incorporated in market prices. Financial analyses were not conducted because data for Components 2, 3, 4, and 5 were derived from secondary data presented in pre-feasibility, and related studies for other projects in the Bicol River Basin. Consultation with local and regional offices of line agencies (such as the National Irrigation Administration, the Department of Public Works, the Department of Agrarian Reform, and the Department of Local Government and Community Development) by BRBDP personnel are required to develop detailed plans and a more precise implementation schedule for all components. The recommendations contained in this report should also be reviewed as they relate to the entire Rinconada IAD. After completing these additional analyses a more detailed economic and financial appraisal should be conducted.

The economic analysis has been applied to the entire project. All components, except Component 5 are considered to be interrelated and necessary to achieve the economic benefits attributed to the project. We were not able to conceptually or empirically describe the economic benefits which would derive from efforts to improve tenure security among leasees and tenant farmers (Component 5). This component is included because as per Presidential Decrees 27 and 474 the Government of the Philippines is committed and BRBDP is mandated to initiate programs which improve tenural security among leasees and share tenants.

The portion of component 4 which seeks to create conditions whereby responsibility of operation and maintenance of the entire BRIS can be delegated to a system wide water users association is not necessary to achieve direct economic benefits. However, we believe that the achievement of this long term objective would produce significant managerial benefits to both NIA and water users.

As per normal practice, the economic analysis compares two situations--without the project and with the project. In this way it was possible to measure the net benefits which can be directly attributed to the projects.

11.2 Data Framework

The framework for the economic evaluation includes the following elements.

11.2.1 Planning Period This includes the investment period plus the economic life of the project. The investment period is three years. The economic life of the project is considered to be 25 years because, at the prevailing costs of borrowed capital per year, discounted benefits which accrue after 25 years have almost no economic value at today's prices. The useful life of major facilities, such as roads, control structures, and canals, is considered to be 40 years. The salvage value of facilities at the end of the planning period is recorded as a negative investment. The planning period for this project includes 28 years from July 1978 to June 2005.

11.2.2 Discount Rate The discount rate of 15 percent per year has been used as an approximation of the opportunity cost of capital in the Philippines.

11.2.3 Costs Economic costs for equipment and fuel are net of taxes and other forms of transfer payments. In the farm budgets, the price of family labor and palay was adjusted to reflect the estimated "shadow-price" value of these items. Prices for hired labor, fertilizer and pesticides have been estimated at prevailing market prices.

Cost items include investment costs as well as operation and maintenance costs for all project inputs. In the economic analysis, only the incremental costs over the without project case are considered.

11.2.4 Benefits Only the incremental benefits which are directly attributable to the project are considered. These are in the form of increased incomes which derive from increased rice production. These are valued at a rate (₱ 1.0/kg.) which corresponds to the international farm-gate price.

These benefits have been derived on the basis of expected rates of growth in rice yields on separate catagories of land which are, in turn, related to the productive capabilites of land. The categories of land which have been used (1R, 2R, and 3R) correspond to those contained in the economic land classification study conducted by the United Nations Development Program/Bureau of Soils in 1975. The results of the economic land classification study (LCS) conducted by the Social Survey Research Unit were used to identify the base year relationships between the economic land classification categories and yields and incomes. For the purposes of this study, net farm incomes were assumed to increase at the same annual percentage rate as do yields. The projected rates of increase were developed on the basis of judgement after examing 1) historic data which describe changes in rice productivity in the Philippines and the Bicol Region from 1954 to 1972, 2) the results of analyses conducted by the Agricultural Economics Department at the International Rice Research Institute, and 3) other relevant experimental analyses.

11.2.5 Feasibility Indicators The economic feasibilty of the project is measured by the following indicators.

1. Internal Rate of Return (IRR) - describes the interest rate at which the discounted present value of the stream of benefits.

2. Benefit-Cost Ratio (BCR) - the index which describes the net benefits which accrue from the project per unit of investment.

3. Net Present Value (NPV) - indicates the difference between the discounted present value of the stream of benefits which would derive from the project and the discounted present value of the income stream which would be generated if the money spent on the project were invested elsewhere at prevailing interest rates.

11.3 Cost Analysis

11.3.1 Investment Cost and Operations and Maintenance Investment costs for construction of major facilities (Component 1), dredging for external drains (Component 2), and expansion of Lake Buhi's storage capacity (Component 3) are estimated to amount to ₱20,004,000. The expenditure are expected to occur during the first three years of the project. Since these facilities are expected to have a useful life of 40 years, they are expected to have a salvage value of ₱ 6,930,000 at the termination of the 25 year economic life of the project. See tables 11.1 and 11.2.

Farmer organization and training, Component 4, will require a total investment of ₱ 1,558,200 during the first five years of the project. Tenural development, Component 5, will require a total investment of ₱ 384,500 during the first three years. See table 11.3.

Operation and maintenance costs for components 1, 2, and 3 increase from zero in the first year to ₱ 513,000 per year in the third year. These estimates are based on an assumed rate of 3 percent per year of the construction costs for component 1 and 2, and 0.1 percent per year of the construction costs of component 3. Costs for components 4 and 5 were estimated on the basis of prevailing costs for personnel and equipment required to implement these components. See tables 8.3 and 9.4.

11.3.2 Farm Costs Farm costs for palay enterprises for the wet and dry season for each of the three major categories of land included in the economic land classification were estimated for a baseline year which included the 1974 wet season and 1975 dry season. Input use coefficients and the costs of inputs other than hired labor and pesticides were derived from Tables LCS. 15 and LCS 16, Social Survey Research Unit, circa December 1975.

Table 11.1. Annual Construction Costs for Component 1, 1978-1990, 2000-2005, Main Canals, Lateral and Sub-Lateral Canals, Farm Ditches, Farm Drains, Farm Roads, and Total.

Financial Year	Main[1] Canal (1)	Lateral and[2] Sub-Lateral Canals (2)	Farm[3] Ditches (3)	Farm[4] Drains (4)	Farm[5] Roads (5)	Total[6] Component One (6)
	Pesos					
1978	320,000	1,184,000	1,733,000	610,000	2,355,000	6,202,000
1979	465,000	812,000	1,425,000	395,000	2,222,000	5,319,000
1980	0	833,000	1,421,000	356,000	1,195,000	3,805,000
1981	0	0	0	0	0	0
1982	0	0	0	0	0	0
1983	0	0	0	0	0	0
1984	0	0	0	0	0	0
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	0	0	0
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	-266,750[7]	-981,375	-1,594,850	-470,000	-1,991,200	-5,304,175

Notes:

1. Estimates for costs of main canal construction are derived from computed volumes of cut and fill material and right of way costs for a given length, see Annex C figure 30 for a typical cross section.

2. Estimates for costs of constructing lateral and sub-lateral canals are derived from computed volumes of cut and fill material and right of way costs for a given length. See Annex C figure 30 for a typical cross section.

3. Estimates for costs of excavating farm ditches are derived from computed volumes of cut and fill material and right of way costs for a given length. See Annex C figure 31 for a typical cross section.

4. Estimates for costs of excavating farm drains are derived from estimated volume of excavation plus right of way costs. See Annex C figure 32 for a typical cross section.

5. Estimates for costs of building farm roads are derived from computed volumes of common borrow, select borrow and gravel surface needed for a given length. See Annex C figure 33 for a typical cross section.

6. Numbers in this column are the sum of numbers presented in columns 1, 2, 3, 4 and 5.

7. Salvage values are estimated to be .325 of construction costs incurred in 1978 plus .35 of construction costs incurred in 1979 plus .375 of construction costs incurred in 1980. Major facilities are assumed to have a useful life of 40 years. Salvage value is determined by straight-line depreciation method at 2.5 percent per year

Table 11.2. Annual Initial Costs for Components 2, 3, 4 and 5; 1978-2005: External Drain, Improvements to Lake Buhi, Farmer Organization and Training and Land Tenure.

Financial Year	Component [1] 2: External Drain (1)	Component [2] 3: Improvement to Lake Buhi (2)	Component [3] 4: Farmer Organization and Training (3)	Component [4] 5: Farm Tenure (4)
	-Pesos-			
1978	1,857,000	0	411,700	165,400
1979	4,420,000	0	772,200	165,700
1980	0	1,397,000	123,600	53,400
1981	0	0	123,600	0
1982	0	0	123,600	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	0	0	0	0
1988	0	0	0	0
1989	0	0	0	0
1990	0	0	0	0
1991	0	0	0	0
1992	0	0	0	0
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	-2,150,525	-523,875	0	0

Notes:

1. Estimated for costs for constructing the external drain are derived from the estimated volume of excavation plus right of way costs. Unit costs were taken from TAMS/TAE Report XXI. See 3.3.

2. Estimates of costs for installation of the control structure for increasing the storage capacity of Lake Buhi were derived from TAMS/TAE Report XXI, Prefeasibility Cost Estimates of Comprehensive Water Resources Development Plan Bicol River Basin. See 3.4.

3. For details of expenditure plan for farmer training and organization see Table 8.3

4. For details of expenditure plan for program to increase tenure security among share tenants see Table 9.4.

5. Salvage values determined according to procedure described in footnoot 7 Table 11.1.

Table 11.3. Annual Maintenance Costs for Components 1, 2 and 3 and Total 1978-2005.

Financial Year	Component 1[1] (1)	Component 2:[2] External Drain (2)	Component 3:[3] Improvements to Lake Buhi (3)	Total[4] Operation and Maintenance Costs (4)
	-----	-----	Pesos -----	-----
1978	0	0	0	0
1979	166,000	56,000	0	122,000
1980	310,000	99,000	0	409,000
1981	413,000	99,000	1,000	513,000
1982	413,000	99,000	1,000	513,000
1983	413,000	99,000	1,000	513,000
1984	413,000	99,000	1,000	513,000
1985	413,000	99,000	1,000	513,000
1986	413,000	99,000	1,000	513,000
1987	413,000	99,000	1,000	513,000
1988	413,000	99,000	1,000	513,000
1989	413,000	99,000	1,000	513,000
1990	413,000	99,000	1,000	513,000
1991	413,000	99,000	1,000	513,000
1992	413,000	99,000	1,000	513,000
1993	413,000	99,000	1,000	513,000
1994	413,000	99,000	1,000	513,000
1995	413,000	99,000	1,000	513,000
1996	413,000	99,000	1,000	513,000
1997	413,000	99,000	1,000	513,000
1998	413,000	99,000	1,000	513,000
1999	413,000	99,000	1,000	513,000
2000	413,000	99,000	1,000	513,000
2001	413,000	99,000	1,000	513,000
2002	413,000	99,000	1,000	513,000
2003	413,000	99,000	1,000	513,000
2004	413,000	99,000	1,000	513,000
2005	413,000	99,000	1,000	513,000

Notes:

1. Maintenance costs for Component 1 are estimated to equal three percent of the construction costs excluding the cost of purchasing rights of way.

2. Maintenance costs for Component 2 are estimated to equal three percent of the construction costs excluding the cost of purchasing the rights of way.

3. Maintenance costs for Component 3 are estimated to equal 0.1 percent of the construction costs.

4. Numbers in this column are the horizontal sumof numbers contained in columns 1, 2 and 3.

December 1975. Prices for hired labor and pesticides were adjusted to reflect market distortions as recommended in TAMS/TAE Technical Report 20, April 1976. See table 11.4.

11.4 Benefits Analysis

11.4.1 Projected Yields and Farm Incomes Net farm incomes for the wet and dry seasons for each of the three major catagories of land were estimated for years from 1978 to 2005. Incomes were estimated to increase at the same compound rate of growth as yields for each season and category of land. This procedure corresponds to procedures used by IBRD appraisals of irrigation projects in other countries. The compound rates of growth which were used are described in table 11.5. These growth rates were derived on the basis of examination of 1) historic performance of rice production in the Philippines from 1954-1972, 2) results of agro-economic investigations of constraints to increasing rice yields in the Philippines conducted at IRRI, and 3) the results of other agronomic trials in the Philippines. For details see TAMS/TAE Technical Report 4, April 1976.

Estimated net farm incomes for wet and dry seasons for each of the three major catagories of land for 1975 through 2005 are described in table 11.6.

11.4.2 Differentiating Net Incomes With and Without the Project The economic land classification conducted in 1975 was used as the basis for deriving estimates of farm incomes with and without the project.

The economic land classification distinguishes among catagories of land which are differentiated on the basis of 1) rainfed or irrigated and 2) degree of inundation. Farm incomes and palay yields obtained during the wet and dry season appear to differentiate according to these categories. See Land Classification summary, Social Survey Research Unit, circa December 1975. According to personnel from the Bureau of Soils and the United Nations Development Program land, if rainfed land, in a given land classification catagory is irrigated, farmers who cultivate such land can expect to obtain yields and incomes which correspond to those obtained by farmers who cultivate land which is currently irrigated. Likewise, much of the land is downgraded by the land classification because it is subject to slight, moderate or severe inundation hazards. If these inundation hazards can be reduced or eliminated, these lands will have production possibilities which correspond to land which does not currently have an inundation hazard.

Currently, all the land (2,809 hectares) included in the project is reportedly irrigated. However, many parcels appear to receive irrigation via cross-paddy flow across distances which exceed 300 meters. Of this, 1,788 hectares are not subject to inundation or are subject to only slight inundation hazards. This land is classified as 1R. About 768 hectares are subject to a moderate inundation hazard and are classified as 2R; about 223 hectares are subject to severe inundation hazards and are classified as 3R. Almost 30 hectares are so seriously inundated that crop production is not possible and these lands are classified as 6D. See Table 11.7 and 11.8.

Table 11.4. Net Income per Hectare from Palay Production on Irrigated Land by Economic Land Classification Category and Crop Season, Camarines Sur, 1974/75.

Item	Wet Season/ ELC Category			Dry Season/ ELC Category		
	1R	2R	3R	1R	2R	3R
	(1)	(2)	(3)	(4)	(5)	(6)
	Pesos					
Receipts[1]	2,613	2,238	1,491	3,294	2,977	2,464
Expenses	1,074	1,212	878	1,111	1,121	950
Expense Items						
Labor[2]	767	589	530	764	577	584
Seeds[3]	110	110	110	99	99	99
Fertilizer[4]	62	40	12	66	42	20
Pesticides[5]	47	38	32	51	42	32
Machinery and Animal Services[6]	50	390	177	88	314	183
Others[7]	38	45	17	43	47	32
Net Income	1,544	1,026	613	2,183	1,856	1,514

Notes:

1. Receipts are the product of the number of cavans per hectare times a shadow price of palay per cavan. Estimated yields were derived from LCS.01, Social Survey Research Unit, circa December, 1975. Palay produced during the wet season is valued at ₱1.1 per kg.; palay produced during the dry season is valued at ₱1.22 per kg. One cavan equals 50 kg. Shadow price estimates for palay were derived from TAMS/TAE Technical Report 20, May, 1976, p. 12.

2. Labor includes hired labor only. All labor is valued at ₱1 per man hour as recommended in TAMS/TAE Technical Report 20.

3. This estimate assumes that farmers use 90 kg. of seed per hectare. Seeds used during the wet season are valued at ₱1.22 per kg.; seeds used during the dry season are valued at ₱1.1 per kg. Sec TAMS/TAE Technical Report 20, May, 1976, p. 12.

4. Fertilizer use estimates based on data from (LCS. 15 and LCS. 16) Social Survey Research Unit, circa December, 1975.

continued on next page -

Table 11.4 Cont'd

5. Pesticides are valued at 83 percent of that reported in LC.15, LC.16, Social Survey Research Unit, circa December 1975, as per recommendation contained in TAMS/TAE Technical Report 20, May 1976, p. 26.

6. Charges for machinery and animal services including fees for operator.

7. Includes fuel and oil

Table 11 .5. Estimated Annual Compound Rates of Growth in Palay Yields (and Incomes) 1975-2000 by Economic Land Classification Category.[1]

Annual Interval	Economic Land Classification Category 1R	2R	3R
1976-80	6.8	4.8	3.4
1981-85	5.0	3.5	2.5
1986-90	3.4	2.4	1.7
1991-95	1.7	1.2	0.9
After 1995	0.0	0.0	0.0

1. Source: Staub, William J. Yields of Palay Under Alternative Conditions of Irrigation and Innundation, CWRS/TAMS/TAE, Technical Report 4, April 1976.

Table 11.6. Estimated Net Income Per Hectare from Palay Production 1975 to 2005 by Economic Land Classification (ELC) Category and Cropping Season.[1]

Year	Wet Season/ ELC Category			Dry Season ELC Category		
	1R	2R	3R	1R	2R	3R
	(1)	(2)	(3)	(4)	(5)	(6)
	----------	----------	---------- Pesos	----------	----------	----------
1975	1,544	1,026	613	2,183	1,856	1,514
1976	1,648	1,075	634	2,331	1,990	1,565
1977	1,760	1,127	656	2,490	2,086	1,618
1978	1,880	1,181	678	2,659	2,186	1,673
1979	2,008	1,238	701	2,840	2,290	1,730
1980	2,145	1,297	725	3,033	2,400	1,790
1981	2,252	1,347	743	3,184	2,484	1,835
1982	2,365	1,394	762	3,343	2,571	1,881
1983	2,483	1,443	781	3,510	2,661	1,928
1984	2,607	1,493	801	3,686	2,754	1,976
1985	2,737	1,545	821	3,870	2,850	2,025
1986	2,830	1,582	835	4,001	2,918	2,059
1987	2,926	1,620	849	4,137	2,988	2,094
1988	3,025	1,659	863	4,278	3,060	2,130
1989	3,127	1,699	887	4,423	3,133	2,166
1990	3,233	1,740	902	4,573	3,208	2,203
1991	3,288	1,761	910	4,651	3,246	2,223
1992	3,344	1,782	918	4,730	3,285	2,243
1993	3,401	1,803	926	4,810	3,324	2,263
1994	3,459	1,824	934	4,892	3,364	2,283
1995	3,518	1,846	942	4,975	3,404	2,304
1996	3,518	1,846	942	4,975	3,404	2,304
1997	3,518	1,846	942	4,975	3,404	2,304
1998	3,518	1,846	942	4,975	3,404	2,304
1999	3,518	1,846	942	4,975	3,404	2,304
2000	3,518	1,846	942	4,975	3,404	2,304
2001	3,518	1,846	942	4,975	3,404	2,304
2002	3,518	1,846	942	4,975	3,404	2,304
2003	3,518	1,846	942	4,975	3,404	2,304
2004	3,518	1,846	942	4,975	3,404	2,304
2005	3,518	1,846	942	4,975	3,404	2,304

1. Numbers in this table were computed by multiplying the compound growth rates described in Table 11.5 to the estimated net farm incomes presented in Table 11.4.

Table 11.7. Proposed Implementation Schedule, Improvements to BRIS by Economic Land Classification Category.[1]

Financial Year	Area Code	Economic Land Classification Category				Total Area
		1R	2R	3R	6d	
		(1)	(2)	(3)	(4)	(5)
		---------------------- Hectares				----------------------
1978	1	492.0	517.0	113.7	10.0	1,132.70
1979	2	656.7	200.4	101.7	15.7	974.50
1980	3	639.3	51.0	8.1	3.8	702.20

1. For details of location see Annex C, Figure 15.

Table 11.8. Amount of Land by Land Classification Category; With and Without Proposed Improvements: 1978-2005

Year	With Project 1R	With Project 2R	With Project 3R	With Project 6d	Without Project 1R	Without Project 2R	Without Project 3R	Without Project 6d
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Hectares							
1978	1787.8	768.4	223.5	29.5	1787.8	768.4	223.5	29.5
1979	2428.5	251.4	109.8	19.5	1787.8	768.4	223.5	29.5
1980	2746.3	51.0	8.1	3.0	1787.8	768.4	223.5	29.5
1981	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1982	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1983	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1984	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1985	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1986	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1987	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1988	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1989	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1990	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1990	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1991	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1992	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1993	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1994	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1995	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1996	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1997	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1998	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
1999	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
2000	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
2001	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
2002	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
2003	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
2004	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5
2005	2809.2	0.0	0.0	0.0	1787.8	768.4	223.5	29.5

1. Estimates presented in this table were calculated from numbers presented in Table 11.6.

The irrigation and drainage network which has been proposed is designed to 1) provide all parcels in the project area with access to irrigation water within one day and 2) reduce the inundation hazard on all land to limits which will provide that land with the production potential of 1R land. If these improvements are made, the entire project area will have the production potential which is ascribed to land classified as 1R. If the project were not constructed, 1788 hectares would have the production potential of land classified as 1R, 768 hectares with the production potential of land classified as 2R, 223 hectares with the production potential of 3R land, and 30 hectares of land which could not be farmed.

This procedure of ascribing benefits makes it possible to discriminate between production and income benefits which can be ascribed to the project and increases in production and income which are likely to derive from other programs such as Masagana 99.

11.4.3 Land Use Intensity Cropping intensity varies according to land classification category. See Table 11.9. Only 33 percent of the 3R land is cultivated during the wet season; about 90 percent of the 2R land is cultivated during the wet season; all of the 1R land is cultivated during the wet season. During the dry season all of the land in each of the land classification categories is generally cultivated.

The estimated number of hectares in each category of land were discounted by these weights to obtain estimates of the area cultivated by season, by land classification category. These estimates are presented in columns 2 and 5 in Tables 11.10, 11.11, 11.12, 11.14, 11.15 and 11.16.

11.4.4 Estimated Net Incomes With and Without the Project Estimated annual net farm income flows, if the project is implemented, are presented by land classification category in Tables 11.10, 11.11, and 11.12. These are summarized on Table 11.13. If the project is constructed, the annual net farm income flows are expected to increase from ₱ 11,029,926 in 1978 to ₱ 23,858,530 in 2005.

Similar estimates, which describe the expected net farm income flows if the project is not constructed, are presented in Tables 11.14, 11.15, and 11.16. These estimates are summarized and aggregated in Table 11.17. If the project is not implemented, annual net farm incomes are expected to increase from ₱ 11,029,926 in 1978 to ₱ 19,652,339 in 2005.

In 1981, the first year after completion of the major project components, the annual net farm income is expected to be ₱ 15,270,810. It would be ₱ 13,614,772 if the project were not implemented. The total annual net farm income stream in 2005 is expected to be ₱ 4,206,191 greater if the project is implemented that it would otherwise be.

Table 11.9. Hectares Cultivated as a Percent of Total Area on Irrigated Land by Economic Land Classification Category, Wet and Dry Season, Barit River Irrigation System Area.

Season	ELC Category		
	1R	2R	3R
	(1)	(2)	(3)
	Percent		
Wet Season	100.0	89.5	32.6
Dry Season	100.0	100.0	100.0

Based on data presented in SS 12.01, Social Survey Research Unit, August 1975.

Table 1110. Area Cultivated and Total Net Farm Income 1978-2005 for Wet Season, Dry Season and Annual; Economic Land Class 1R, with Project.

Financial Year	Wet Season			Dry Season			
	Farm Income[1] per Hectare	Hectares[2] Cultivated	Total Income[3]	Farm Income[4] per Hectare	Hectares[5] Cultivated	Total[6] Income	Annual[7] Income
	(1) Pesos	(2) Hectares	(3) Pesos	(4) Pesos	(5) Hectares	(6) Pesos	
1978	1,880	1,788	3,361,064	2,659	1,788	4,753,760	8,114,824
1979	2,008	2,429	4,876,428	2,840	2,429	6,896,940	11,773,368
1980	2,145	2,746	5,890,814	3,033	2,746	8,329,528	14,220,342
1981	2,252	2,809	6,326,318	3,184	2,809	8,944,492	15,270,810
1892	2,365	2,809	6,643,758	3,343	2,809	9,391,156	16,034,914
1983	2,483	2,809	6,975,244	3,510	2,809	9,860,292	16,835,536
1984	2,607	2,809	7,323,584	3,686	2,809	10,354,711	17,678,295
1985	2,737	2,809	7,688,780	3,870	2,809	10,871,604	18,560,384
1986	2,830	2,809	7,950,036	4,001	2,809	11,239,609	19,189,645
1987	2,926	2,809	8,219,719	4,132	2,809	11,607,614	19,827,333
1988	3,025	2,809	8,497,830	4,278	2,809	12,017,757	20,515,587
1989	3,127	2,809	8,784,368	4,423	2,809	12,425,091	21,209,459
1990	3,233	2,809	9,082,144	4,473	2,809	12,565,551	22,302,239
1991	3,288	2,809	9,236,650	4,651	2,809	13,065,589	22,681,481
1992	3,344	2,809	9,393,965	4,730	2,809	13,287,516	23,066,341
1993	3,401	2,809	9,554,089	4,810	2,809	13,512,252	23,459,629
1994	3,459	2,809	9,717,023	4,892	2,809	13,742,606	23,858,536
1995	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
1996	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
1997	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
1998	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
1999	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
2000	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
2001	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
2002	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
2003	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
2004	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536
2005	3,518	2,809	9,882,766	4,975	2,809	13,975,770	23,858,536

continued on next page

Table 11.10 (Cont'd.)

Notes:

1. From column 1, Table 11.6.
2. From column 1, Table 11.8 multiplied by proportion of area cultivated, column 1, Table 11.9.
3. Column 1 multiplied by column 2.
4. From column 4, Table 11.6.
5. Column 1, Table 11.8 multiplied by proportion of area cultivated, column 1, Table 11.9.
6. Column 4 multiplied by column 5.
7. Column 3 plus column 6.

Table 11.11. Area Cultivated and Total Net Farm Income 1978-2005 for Wet Season, Dry Season and Annual; Economic Land Class 2R, With Project.

Financial Year	Wet Season			Dry Season			
	Farm Income[1] per Hectare	Hectares[2] Cultivated	Total Income[3]	Farm Income[4] per Hectare	Hectares[5] Cultivated	Total Income[6]	Annual Income[7]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Pesos	Hectares	Pesos	Pesos	Hectares	Pesos	Pesos
1978	1,181	688	812,173	2,186	768	1,679,722	2,491,895
1979	1,238	225	278,550	2,290	251	575,706	854,256
1980	1,297	46	59,143	2,400	51	122,400	181,543
1981	1,347	0	0	2,484	0	0	0
1982	1,394	0	0	2,571	0	0	0
1983	1,443	0	0	2,661	0	0	0
1984	1,493	0	0	2,754	0	0	0
1985	1,545	0	0	2,850	0	0	0
1986	1,582	0	0	2,918	0	0	0
1987	1,620	0	0	2,988	0	0	0
1988	1,659	0	0	3,060	0	0	0
1989	1,699	0	0	3,133	0	0	0
1990	1,740	0	0	3,208	0	0	0
1991	1,761	0	0	3,246	0	0	0
1992	1,782	0	0	3,285	0	0	0
1993	1,802	0	0	3,324	0	0	0
1994	1,824	0	0	3,264	0	0	0
1995	1,846	0	0	3,404	0	0	0
1996	1,846	0	0	3,404	0	0	0
1997	1,846	0	0	3,404	0	0	0
1998	1,846	0	0	3,404	0	0	0
1999	1,846	0	0	3,404	0	0	0
2000	1,846	0	0	3,404	0	0	0
2001	1,846	0	0	3,404	0	0	0
2002	1,846	0	0	3,404	0	0	0
2003	1,846	0	0	3,404	0	0	0
2004	1,846	0	0	3,404	0	0	0
2005	1,846	0	0	3,404	0	0	0

Continued on next page

Table 11.11 (Cont'd.)

Notes:

1. From column 2, Table 11.6.
2. Column 2, Table 11.8 multiplied by proportion of area cultivated. column 2, Table 11.9.
3. Column 1 multiplied by column 2.
4. From column 5, Table 11.6.
5. Column 2, Table 11.8 multiplied by proportion of area cultivated, column 2, Table 11.9.
6. Column 4 multiplied by column 5.
7. Column 3 plus column 6.

Table 11.12. Area Cultivated and Total Net Farm Income 1978-2005 for Wet Season, Dry Season and Annual; Economic Land Class 3R, With Project.

Financial Year	Wet Season			Dry Season			
	Farm Income per Hectare[1]	Hectares Cultivated[2]	Total Income[3]	Farm Income per Hectare[4]	Hectares Cultivated[5]	Total Income[6]	Annual Income[7]
	(1) Pesos	(2) [illegible]ares	(3) Pesos	(4) Pesos	(5) Hectares	(6) Pesos	(7) Pesos
1978	678	[illegible]3	49,291	1,673	224	373,916	423,207
1979	701	[illegible]6	25,096	1,730	110	189,954	215,050
1980	725	3	1,885	1,790	8	14,499	16,384
1981	743	0	0	1,835	0	0	0
1982	762	0	0	1,881	0	0	0
1983	781	0	0	1,928	0	0	0
1984	801	0	0	1,976	0	0	0
1985	821	0	0	2,025	0	0	0
1986	835	0	0	2,059	0	0	0
1987	849	0	0	2,094	0	0	0
1988	863	0	0	2,130	0	0	0
1989	887	0	0	2,166	0	0	0
1990	902	0	0	2,203	0	0	0
1991	910	0	0	2,223	0	0	0
1992	918	0	0	2,243	0	0	0
1993	926	0	0	2,263	0	0	0
1994	934	0	0	2,283	0	0	0
1995	942	0	0	2,304	0	0	0
1996	942	0	0	2,304	0	0	0
1997	942	0	0	2,304	0	0	0
1998	942	0	0	2,304	0	0	0
1999	942	0	0	2,304	0	0	0
2000	947	0	0	2,304	0	0	0
2001	942	0	0	2,304	0	0	0
2002	942	0	0	2,304	0	0	0
2003	942	0	0	2,304	0	0	0
2004	942	0	0	2,304	0	0	0
2005	942	0	0	2,304	0	0	0

Continued on next page

Table 11.12 (Cont'd.)

Notes:

1. From column 3, Table 11.6.
2. Column 3, Table 11.8 multiplied by proportion of area cultivated, column 3, Table 11.9.
3. Column 1 multiplied by column 2.
4. From column 6, Table 11.6.
5. Column 3, Table 11.8 multiplied by proportion of area cultivated, column 3, Table 11.9.
6. Column 4 multiplied by column 5.
7. Column 3 plus column 6.

Table 11.13. Annual Income from Palay Production 1978-2005 for Economic Land Classes 1R, 2R, 3R and Total, With Project.

Financial Year	Land Class (1) Pesos	Land Class (2) Pesos	Land Class (3) Pesos	All Land Classes (4) Pesos
1978	8,114,824	2,491,895	423,207	11,029,926
1979	11,773,368	854,256	215,050	12,842,674
1980	14,220,342	181,540	16,384	14,418,266
1981	15,270,810	0	0	15,270,810
1982	16,034,914	0	0	16,034,914
1983	16,835,536	0	0	16,835,536
1984	17,678,295	0	0	17,678,295
1985	18,560,384	0	0	18,560,384
1986	19,189,645	0	0	19,189,645
1987	19,827,333	0	0	19,827,333
1988	20,515,587	0	0	20,515,587
1989	21,209,459	0	0	21,209,459
1990	21,647,695	0	0	21,647,695
1991	22,302,239	0	0	22,302,239
1992	22,681,481	0	0	22,681,481
1993	23,066,341	0	0	23,066,341
1994	23,459,629	0	0	23,459,629
1995	23,858,536	0	0	23,858,536
1996	23,858,536	0	0	23,858,536
1997	23,858,536	0	0	23,858,536
1998	23,858,536	0	0	23,858,536
1999	23,858,536	0	0	23,858,536
2000	23,858,536	0	0	23,858,536
2001	23,858,536	0	0	23,858,536
2002	23,858,536	0	0	23,858,536
2003	23,858,536	0	0	23,858,536
2004	23,858,536	0	0	23,858,536
2005	23,858,536	0	0	23,858,536

Notes:

1. From column 7, Table 11.10.
2. From column 7, Table 11.11.
3. From column 7, Table 11.12.
4. Column 1 plus column 2 plus column 3.

Table 11.14. Area Cultivated and Total Net Farm Income 1978-2005 for Wet Season, Dry Season and Annual; Economic Land Class 1R, Without Project

Financial Year	Wet Season: Farm Income per Hectare[1] (1) Pesos	Wet Season: Hectares Cultivated[2] (2) ha.	Wet Season: Total Income[3] (3) Pesos	Dry Season: Farm Income per Hectare[4] (4) Pesos	Dry Season: Hectares Cultivated[5] (5) ha.	Dry Season: Total Income[6] (6) Pesos	Annual Income[7] (7) Pesos
1978	1,880	1,788	3,361,064	2,659	1,788	4,753,760	8,114,824
1979	2,608	1,788	3,589,902	2,840	1,788	5,077,352	8,667,254
1980	2,145	1,788	3,834,831	3,033	1,788	5,422,397	9,257,228
1981	2,252	1,788	4,026,126	3,184	1,788	5,692,355	9,718,481
1982	2,365	1,788	4,228,147	3,343	1,788	5.976,615	10,204,762
1983	2,483	1,788	4,439,107	3,510	1,788	6,275,178	10,714,285
1984	2,607	1,788	4,660,795	3,686	1,788	6,589,831	10,935,973
1985	2,737	1,788	4,893,209	3,870	1,788	6,918,786	11,811,995
1986	2,830	1,788	5,059,474	4,001	1,788	7,152,988	12,212,462
1987	2,926	1,788	5,231,103	4,132	1,788	7,387,190	12,618,293
1988	3,025	1,788	5,408,095	4,278	1,788	7,648,208	13,056,303
1989	3,127	1,788	5,590,451	4,423	1,788	7,907,439	13,497,890
1990	3,233	1,788	5,779,957	4,473	1,788	7,996,829	13,776,786
1991	3,288	1,788	5,878,286	4,651	1,788	8,315,058	14,193,344
1992	3,344	1,788	5,978,403	4,730	1,788	8,456,294	14,434,697
1993	3,401	1,788	6,080,308	4,810	1,788	8,599,318	14,679,626
1994	3,459	1,788	6,184,000	4,892	1,788	8,745,918	14,929,918
1995	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
1996	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
1997	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
1998	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
1999	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
2000	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
2001	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
2002	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
2003	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
2004	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183,785
2005	3,518	1,788	6,289,480	4,975	1,788	8,894,305	15,183.785

Continued on next page

Table 11.14 (Cont'd.)

Notes:

1. From column 1, Table 11.6.
2. Column 5, Table 11.8 multiplied by proportion of area cultivated, column 1. Table 11.9.
3. Column 1 multiplied by column 2.
4. From column 4, Table 11.6.
5. Column 1, Table 11.8 multiplied by proportion of area cultivated, column 1, Table 11.9.
6. Column 4 multiplied by column 5.
7. Column 3 plus column 6.

Table 11.15. [illegible]a Cultivated and Total Net Farm Income 1978-2005 for Wet Season, Dry Season and Annual; Economic Land Class 2R, Without Project.

Financial Year	Wet Season			Dry Season			
	Farm Income per Hectare[1]	Hectares Cultivated[2]	Total Income[3]	Farm Income per Hectare[4]	Hectares Cultivated[5]	Total Income[6]	Annual Income[7]
	(1) Pesos	(2) Hectares	(3) Pesos	(4) Pesos	(5) Hectares	(6) Pesos	(7) Pesos
1978	1,181	688	812,173	2,186	768	1,679,722	2,491,895
1979	1,238	688	882,319	2,290	768	1,759,636	2,641,955
1980	1,297	688	891,947	2,400	768	1,844,160	2,736,107
1981	1,347	688	926,331	2,484	768	1,908,706	2,835,037
1982	1,394	688	958,654	2,571	768	1,975,556	2,934,210
1983	1,443	688	992,351	2,661	768	2,044,712	3,037,063
1984	1,493	688	1,026,736	2,754	768	2,116,174	3,142,910
1985	1,545	688	1,062,497	2,850	768	2,189,940	3,252,437
1986	1,582	688	1,087,941	2,918	768	2,242,191	3,330,132
1987	1,620	688	1,114,074	2,988	768	2,295,979	3,410,053
1989	1,659	688	1,140,894	3,060	768	2,351,304	3,492,198
1990	1,599	688	1,168,402	3,133	768	2,407,398	3,575,800
1991	1,740	688	1,196,598	3,208	768	2,465,027	3,661,625
1992	1,761	688	1,211,040	3,246	768	2,494,226	3,705,266
1993	1,782	688	1,225,481	3,285	768	2,524,194	3,749,675
1994	1,803	688	1,239,923	3,324	768	2,554,162	3,794,085
1995	1,824	688	1,254,365	3,364	768	2,584,897	3,839,262
1996	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
1997	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
1998	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
1999	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
2000	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
2001	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
2002	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
2003	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
2004	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127
2005	1,846	688	1,269,494	3,404	768	2,615,633	3,885,127

Continued on next page

Table 11.15 (Cont'd.)

Notes:

1. From column 2, Table 11.6.
2. Column 6, Table 11.8 multiplied by proportion of area cultivated, column 2, Table 11.9.
3. Column 1 multiplied by column 2.
4. From column 5, Table 11.6.
5. Column 6, Table 11.8 multiplied by proportion of area cultivated, column 2, Table 11.9.
6. Column 4 multiplied by column 5.
7. Column 3 plus column 6.

Table 1116. Area Cultivated and Total Net Farm Income 1978-2005 for Wet Season, Dry Season and Annual; Economic Land Class 3R, Without Project.

Financial Year	Wet Season			Dry Season			
	Farm Income per Hectare[1]	Hectares Cultivated[2]	Total Income[3]	Farm Income per Hectare[4]	Hectares Cultivated[5]	Total Income[6]	Annual Income[7]
	(1) Pesos	(2) Hectares	(3) Pesos	(4) Pesos	(5) Hectares	(6) Pesos	(7) Pesos
1978	678	73	49,291	1,673	224	373,916	423,207
1979	701	73	50,963	1,730	224	386,655	437,618
1980	725	73	52,707	1,790	224	400,065	542,772
1981	743	73	54,016	1,835	224	410,123	464,139
1982	762	73	55,397	1,881	224	420,403	475,800
1983	781	73	56,779	1,928	224	420,908	487,687
1984	801	73	58,233	1,976	224	441,636	499,869
1985	821	73	59,687	2,025	224	452,588	512,275
1986	835	73	60,705	2,059	224	460,187	520,892
1987	849	73	61,722	2,094	224	468,009	529,731
1988	863	73	62,740	2,130	224	476,055	538,795
1989	887	73	64,485	2,166	224	484,101	548,586
1990	902	73	65,575	2,203	224	492,371	557,946
1991	910	73	66,157	2,223	224	496,841	562,998
1992	918	73	66,739	2,243	224	501,311	568,050
1993	926	73	67,320	2,263	224	505,781	573,101
1994	934	73	67,902	2,283	224	510,251	578,153
1995	942	73	68,483	2,304	224	514,944	578,153
1996	942	73	68,483	2,304	224	514,944	583,427
1997	942	73	68,483	2,304	224	514,944	583,427
1998	942	73	68,483	2,304	224	514,944	583,427
1999	942	73	68,483	2,304	224	514,944	583,427
2000	942	73	68,483	2,304	224	514,944	583,427
2001	942	73	68,483	2,304	224	514,944	583,427
2002	942	73	68,483	2,304	224	514,944	583,427
2003	942	73	68,483	2,304	224	514,944	583,427
2004	942	73	68,483	2,304	224	514,944	583,427
2005	942	73	68,483	2,304	224	514,944	583,427

Continued on next page

Table 11.16 (Cont'd.)

Notes:

1. From column 3, Table 11.6.
2. Column 7, Table 11.8 multiplied by proportion of area cultivated, column 3. Table 11.9.
3. Column 1 multiplied by column 2.
4. From column 6, Table 11.6.
5. Column 7, Table 11.8 multiplied by proportion of area cultivated, column 3, Table 11.9.
6. Column 4 multiplied by column 5.
7. Column 3 plus column 6.

Table 11.17. Annual Income from Palay Production 1978-2005 for Economic Land Classes 1R, 2R, 3R and Total, Without Project.

Financial Year	Land Class 1 R	Land Class 2 R_{f2}	Land Class 3 R_{f3}	All Land Classes
	(1) Pesos	(2) Pesos	(3) Pesos	(4) Pesos
1978	8,114,824	2,491,895	423,207	11,029,926
1989	8,667,254	2,641,955	437,618	11,746,827
1980	9,257,228	2,736,107	452,772	12,446,107
1981	9,718,481	2,835,037	464,139	13,017,657
1982	10,204,762	2,934,210	475,800	13,614,772
1983	10,714,285	3,037,063	487,687	14,239,035
1984	10,935,973	3,142,910	499,869	14,578,752
1985	11,811,995	3,252,437	312,275	15,576,707
1986	12,212,462	3,330,132	520,892	16,063,486
1987	12,618,293	3,410,053	529,731	16,558,077
1988	13,056,303	3,492,198	538,795	17,087,296
1989	13,497,890	3,575,800	548,586	17,622,276
1990	13,776,786	3,661,625	557,946	17,996,357
1991	14,193,344	3,705,266	562,998	18,461,608
1992	14,434,697	3,749,675	568,050	18,752,422
1993	14,679,626	3,794,085	573,101	19,046,812
1994	14,929,918	3,839,262	578,153	19,347,333
1995	15,183,785	3,885,127	583,427	19,652,339
1996	15,183,785	3,885,127	583,427	19,652,339
1997	15,183,785	3,885,127	583,427	19,652,339
1998	15,183,785	3,885,127	583,427	19,652,339
1999	15,183,785	3,885,127	583,427	19,652,339
2000	15,183,785	3,885,127	583,427	19,652,339
2001	15,183,785	3,885,127	583,427	19,652,339
2002	15,183,785	3,885,127	583,427	19,652,339
2003	15,183,785	3,885,127	583,427	19,652,339
2004	15,183,785	3,885,127	583,427	19,652,339
2005	15,183,785	3,885,127	583,427	19,652,339

Notes:

1. From column 7, Table 11.14.
2. From column 7, Table 11.15.
3. From column 7, Table 11.16.
4. Column 1 plus column 2 plus column 3.

11.5 Results of Economic Analysis

Economic analysis performed on data which reflect the estimated construction and maintenance costs for Components 1, 2, 3, 4, and 5 and the estimated benefits do not indicate that the proposed program is economically feasible at a 15 percent opportunity cost for borrowed capital. The estimated internal rate of return of investment was calculated to be 11.7 percent. See Tables 11.18 and 11.19. If the cost of borrowed capital is estimated at 15 percent, the benefit-cost ratio is 0.794 and the discounted present value of the project investment is -₱ 4,605,000.

We suspect, however, that the data used in this analysis substantially over estimates the costs for component 1 and under estimates the net benefits to be derived. The NIA has reportedly initiated farm road construction programs within the BRIS project area. To the extent that this program is financed out of a separate account and included portions of the proposed road network (component 1), these costs should be deleted from those reflected in this study.

Also, many of the proposed farm ditches in the BRIS project area already exist. To the extent that this is true, the costs of the proposed farm ditch network should also be reduced.

Finally, many portions of the project area, which in this analysis are considered to be irrigated, are located at places which are very remote from a terminal distribution point. The quality of irrigation services received by farmers in these parcels may not be sufficient to justify labeling these farms as irrigated. To the extent that this is true the projected income stream <u>without</u> the project will be less than that which has been estimated. This adjustment will, in turn, cause the net income stream which is generated by the project to exceed that which has been estimated.

We did not have access to data which are requied to make the desired revisions. However, by making assumptions about the NIA road construction program and the probable extent of the existing farm ditch network we examined the economic feasibility of the proposed investment program under these conditions. This analysis indicates that, when these factors are considered, the proposed project is economically feasible. For details, see the next section.

11.5.1 <u>Sensitivity Analysis: Farm Ditches</u> As much as 50 percent of the proposed farm ditch network may already exist in the project area. If this is true, the construction costs for Component 1 may decrease to 86 percent of that estimated in the "base case". Maintenance costs will probably decrease to 9 percent of that estimated in the "base case".

Under these conditions the estimated internal rate of return for the project is 13.0 percent. The benefit-cost ratio is 0.878 and the discount present value of project investments is ₱ 2,453,000. See tables 11.20 & 11.21

Table 11.18

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

YEAR	INVESTMENT COMPONENT 1	INVESTMENT COMPONENT 2	INVESTMENT COMPONENT 3	INVESTMENT COMPONENT 4	INVESTMENT COMPONENT 5	MAINTENANCE	FARM INCOME WITH PROJECT	FARM INCOME WITHOUT PROJECT
1978	6202.	1857.	0.	415.	165.	0.	11030.	11030.
1979	5319.	1420.	0.	772.	166.	222.	12843.	11747.
1980	3805.	0.	1397.	124.	53.	409.	14418.	12446.
1981	0.	0.	0.	124.	0.	513.	15271.	13018.
1982	0.	0.	0.	124.	0.	513.	16035.	13615.
1983	0.	0.	0.	0.	0.	513.	16836.	14239.
1984	0.	0.	0.	0.	0.	513.	17678.	14579.
1985	0.	0.	0.	0.	0.	513.	18560.	15577.
1986	0.	0.	0.	0.	0.	513.	19190.	16063.
1987	0.	0.	0.	0.	0.	513.	19827.	16558.
1988	0.	0.	0.	0.	0.	513.	20516.	17087.
1989	0.	0.	0.	0.	0.	513.	21209.	17622.
1990	0.	0.	0.	0.	0.	513.	21648.	17996.
1991	0.	0.	0.	0.	0.	513.	22302.	18462.
1992	0.	0.	0.	0.	0.	513.	22681.	18752.
1993	0.	0.	0.	0.	0.	513.	23066.	19047.
1994	0.	0.	0.	0.	0.	513.	23460.	19347.
1995	0.	0.	0.	0.	0.	513.	23859.	19652.
1996	0.	0.	0.	0.	0.	513.	23859.	19652.
1997	0.	0.	0.	0.	0.	513.	23859.	19652.
1998	0.	0.	0.	0.	0.	513.	23859.	19652.
1999	0.	0.	0.	0.	0.	513.	23859.	19652.
2000	0.	0.	0.	0.	0.	513.	23859.	19652.
2001	0.	0.	0.	0.	0.	513.	23859.	19652.
2002	0.	0.	0.	0.	0.	513.	23859.	19652.
2003	0.	0.	0.	0.	0.	513.	23859.	19652.
2004	0.	0.	0.	0.	0.	513.	23859.	19652.
2005	-5305.	-1101.	-524.	0.	0.	513.	23859.	19652.

Table 11.19

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

INTERNAL RETURN ON TOTAL CAPITAL 11.653 PERCENT

PERIOD NO.	PERIOD YEAR	INVESTMENT (PESO1000) FACILITIES	INVESTMENT (PESO1000) WORKING CAPITAL	INVESTMENT (PESO1000) TOTAL	OPERATING (PESO1000) TOTAL REVENUE	OPERATING (PESO1000) OPERATING EXPENSES	OPERATING (PESO1000) NET REVENUE	PRESENT VALUE FACTOR	PRESENT VALUE TOTAL INVESTMENT	PRESENT VALUE NET REVENUE
1	1978	8639.	0.	8639.	11030.	11030.	0.	1.0000	8639.	0.
2	1979	7677.	222.	7899.	12843.	11747.	1096.	0.8956	7075.	982.
3	1980	5379.	409.	5788.	14418.	12446.	1972.	0.8022	4643.	1582.
4	1981	124.	513.	637.	15271.	13018.	2253.	0.7184	458.	1619.
5	1982	124.	513.	637.	16035.	13615.	2420.	0.6435	410.	1557.
6	1983	0.	513.	513.	16836.	14239.	2597.	0.5763	296.	1497.
7	1984	0.	513.	513.	17678.	14579.	3099.	0.5162	265.	1600.
8	1985	0.	513.	513.	18560.	15577.	2983.	0.4623	237.	1379.
9	1986	0.	513.	513.	19190.	16063.	3127.	0.4140	212.	1295.
10	1987	0.	513.	513.	19827.	16558.	3269.	0.3708	190.	1212.
11	1988	0.	513.	513.	20516.	17087.	3429.	0.3321	170.	1139.
12	1989	0.	513.	513.	21209.	17622.	3587.	0.2975	153.	1067.
13	1990	0.	513.	513.	21648.	17996.	3652.	0.2664	137.	973.
14	1991	0.	513.	513.	22302.	18462.	3840.	0.2386	122.	916.
15	1992	0.	513.	513.	22681.	18752.	3929.	0.2137	110.	840.
16	1993	0.	513.	513.	23066.	19047.	4019.	0.1914	98.	769.
17	1994	0.	513.	513.	23460.	19347.	4113.	0.1714	88.	705.
18	1995	0.	513.	513.	23859.	19652.	4207.	0.1535	79.	646.
19	1996	0.	513.	513.	23859.	19652.	4207.	0.1375	71.	579.
20	1997	0.	513.	513.	23859.	19652.	4207.	0.1232	63.	518.
21	1998	0.	513.	513.	23859.	19652.	4207.	0.1103	57.	464.
22	1999	0.	513.	513.	23859.	19652.	4207.	0.0988	51.	416.
23	2000	0.	513.	513.	23859.	19652.	4207.	0.0885	45.	372.
24	2001	0.	513.	513.	23859.	19652.	4207.	0.0793	41.	333.
25	2002	0.	513.	513.	23859.	19652.	4207.	0.0710	36.	299.
26	2003	0.	513.	513.	23859.	19652.	4207.	0.0636	33.	267.
27	2004	0.	513.	513.	23859.	19652.	4207.	0.0569	29.	240.
28	2005	-6930.	513.	-6417.	23859.	19652.	4207.	0.0510	-327.	215.
	TOTAL	15013.	13456.	28469.	579019.	483357.	95662.		23479.	23479.

INTEREST PER CENT	BENEFIT/COST RATIO	PRESENT VALUE IN PESO1000 REVENUE	PRESENT VALUE IN PESO1000 OUTLAY	PRESENT VALUE IN PESO1000 BALANCE
10.000	1.137	27403.	24101.	3302.
11.000	1.051	24920.	23718.	1202.
12.000	0.975	22764.	23355.	-592.
13.000	0.907	20882.	23013.	-2131.
14.000	0.848	19233.	22690.	-3458.
15.000	0.794	17780.	22385.	-4605.

Base case without application of any column scalars

Table 11.20

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

YEAR	INVESTMENT COMPONENT 1	INVESTMENT COMPONENT 2	INVESTMENT COMPONENT 3	INVESTMENT COMPONENT 4	INVESTMENT COMPONENT 5	MAINTENANCE	FARM INCOME WITH PROJECT	FARM INCOME WITHOUT PROJECT
*SCALERS:	0.86	1.00	1.00	1.00	1.00	0.92	1.00	1.00
1978	5334.	1857.	0.	415.	165.	0.	11030.	11030.
1979	4574.	1420.	0.	772.	166.	204.	12843.	11747.
1980	3272.	0.	1397.	124.	53.	376.	14418.	12446.
1981	0.	0.	0.	124.	0.	472.	15271.	13018.
1982	0.	0.	0.	124.	0.	472.	16035.	13615.
1983	0.	0.	0.	0.	0.	472.	16836.	14239.
1984	0.	0.	0.	0.	0.	472.	17678.	14579.
1985	0.	0.	0.	0.	0.	472.	18560.	15577.
1986	0.	0.	0.	0.	0.	472.	19190.	16063.
1987	0.	0.	0.	0.	0.	472.	19827.	16558.
1988	0.	0.	0.	0.	0.	472.	20516.	17087.
1989	0.	0.	0.	0.	0.	472.	21209.	17622.
1990	0.	0.	0.	0.	0.	472.	21648.	17996.
1991	0.	0.	0.	0.	0.	472.	22302.	18452.
1992	0.	0.	0.	0.	0.	472.	22681.	18752.
1993	0.	0.	0.	0.	0.	472.	23066.	19047.
1994	0.	0.	0.	0.	0.	472.	23460.	19347.
1995	0.	0.	0.	0.	0.	472.	23859.	19652.
1996	0.	0.	0.	0.	0.	472.	23859.	19652.
1997	0.	0.	0.	0.	0.	472.	23859.	19652.
1998	0.	0.	0.	0.	0.	472.	23859.	19652.
1999	0.	0.	0.	0.	0.	472.	23859.	19652.
2000	0.	0.	0.	0.	0.	472.	23859.	19652.
2001	0.	0.	0.	0.	0.	472.	23859.	19652.
2002	0.	0.	0.	0.	0.	472.	23859.	19652.
2003	0.	0.	0.	0.	0.	472.	23859.	19652.
2004	0.	0.	0.	0.	0.	472.	23859.	19652.
2005	-4562.	-1101.	-524.	0.	0.	472.	23859.	19652.

* Investment component I is estimated at 86 percent of that described in the "base case", maintenance costs are estimated at 92 percent of that described in the "base case". These adjustments are indicative of changes in project related costs if 50 percent of the proposed farm ditch network already exists.

Table 11.21

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

INTERNAL RETURN ON TOTAL CAPITAL 13.043 PERCENT

PERIOD		INVESTMENT (PESO1000)			OPERATING (PESO1000)			PRESENT VALUE FACTOR	PRESENT VALUE	
NO.	YEAR	FACILITIES	WORKING CAPITAL	TOTAL	TOTAL REVENUE	OPERATING EXPENSES	NET REVENUE		TOTAL INVESTMENT	NET REVENUE
1	1978	7771.	0.	7771.	11030.	11030.	0.	1.0000	7771.	0.
2	1979	6932.	204.	7137.	12843.	11747.	1096.	0.8846	6313.	970.
3	1980	4846.	376.	5223.	14418.	12446.	1972.	0.7825	4087.	1543.
4	1981	124.	472.	596.	15271.	13018.	2253.	0.6923	413.	1560.
5	1982	124.	472.	596.	16035.	13615.	2420.	0.6124	365.	1482.
6	1983	0.	472.	472.	16836.	14239.	2597.	0.5417	256.	1407.
7	1984	0.	472.	472.	17678.	14579.	3099.	0.4792	226.	1695.
8	1985	0.	472.	472.	18560.	15577.	2983.	0.4239	200.	1265.
9	1986	0.	472.	472.	19190.	16063.	3127.	0.3750	177.	1173.
10	1987	0.	472.	472.	19827.	16558.	3269.	0.3317	157.	1084.
11	1988	0.	472.	472.	20516.	17087.	3429.	0.2935	139.	1006.
12	1989	0.	472.	472.	21209.	17622.	3587.	0.2596	123.	931.
13	1990	0.	472.	472.	21648.	17996.	3652.	0.2296	108.	839.
14	1991	0.	472.	472.	22302.	18462.	3840.	0.2032	96.	780.
15	1992	0.	472.	472.	22681.	18752.	3929.	0.1797	85.	706.
16	1993	0.	472.	472.	23066.	19047.	4019.	0.1590	75.	639.
17	1994	0.	472.	472.	23460.	19347.	4113.	0.1406	66.	578.
18	1995	0.	472.	472.	23859.	19652.	4207.	0.1244	59.	523.
19	1996	0.	472.	472.	23859.	19652.	4207.	0.1101	52.	463.
20	1997	0.	472.	472.	23859.	19652.	4207.	0.0974	46.	410.
21	1998	0.	472.	472.	23859.	19652.	4207.	0.0861	41.	362.
22	1999	0.	472.	472.	23859.	19652.	4207.	0.0762	36.	321.
23	2000	0.	472.	472.	23859.	19652.	4207.	0.0674	32.	284.
24	2001	0.	472.	472.	23859.	19652.	4207.	0.0596	28.	251.
25	2002	0.	472.	472.	23859.	19652.	4207.	0.0527	25.	222.
26	2003	0.	472.	472.	23859.	19652.	4207.	0.0467	22.	196.
27	2004	0.	472.	472.	23859.	19652.	4207.	0.0413	19.	174.
28	2005	-6187.	472.	-5715.	23859.	19652.	4207.	0.0365	-209.	154.
	TOTAL	13610.	12380.	25990.	579019.	483357.	95662.		20806.	20806.

INTEREST PER CENT	BENEFIT/COST RATIO	PRESENT VALUE IN PESO1000		
		REVENUE	OUTLAY	BALANCE
10.000	1.256	27403.	21821.	5582.
11.000	1.161	24920.	21468.	3452.
12.000	1.077	22764.	21134.	1630.
13.000	1.003	20882.	20819.	63.
14.000	0.937	19233.	20523.	-1290.
15.000	0.878	17780.	20243.	-2463.

ALTERNATIVE:

Investment costs for component 1 are 86 percent of "base case" (Table 11.18); maintenance costs are 90 percent of "base case".

11.5.2 Sensitivity Analysis: Roads The NIA is reportedly investing about ₱ 4,000,000 in a farm road construction program within the Project area. If the costs of these improvements and the related maintenance costs are deleted from the cost estimates which are attrib to this project, the internal rate of return is 14.6 percent. The benefit cost ratio is 0.974, and the net present value of project investments is ₱ 472,000. See Tables 11.22 and 11.23.

11.5.3 Sensitivity Analysis: Farm Ditches and Roads If project costs are adjusted to reflect both the estimated existing farm ditch network and the NIA road construction program, construction costs for Component 1 decrease to 60 percent of that estimated in the "base case". When these adjustments are made, the project investments obtain an internal rate of return of 16.6 percent. The benefit-cost ratio is 1.19 and the net present vlaue of the project is ₱ 1,671,000. See Tables 11.24 and 11.25.

11.5.4 Sensitivity Analysis: Rainfed Land If a moderate portion of the land in the project area which is currently considered to be irrigated is rainfed, the annual farm income stream, will be less than that described in Table 11.18. For purposes of illustration we examined the effects on the economic feasibility which would result if a sufficient portion of the land was actually rainfed to justify reducing the annual farm income stream without the project to 95 percent of that described in Table 11.18. Under these assumptions, the internal rate of return would be 15.6 percent. The benefit-cost ratio would be 1.04 and the discounted present value of the project investments would be ₱ 826,000. See Tables 11.26 and 11.27.

11.5.5 Sensitivity Analysis: Roads, Farm Ditches and Rainfed Land If the assumptions analysed in 11.5.1, 11.5.2 and 11.5.4 are considered jointly, the internal rate of return is 22.2 percent. The benefit-cost ratio is 1.4 and the discounted present value of project investments is ₱ 7,102,000. See Tables 11.28 and 11.29.

Table 11.22

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

YEAR	INVESTMENT COMPONENT 1	INVESTMENT COMPONENT 2	INVESTMENT COMPONENT 3	INVESTMENT COMPONENT 4	INVESTMENT COMPONENT 5	MAINTENANCE	FARM INCOME WITH PROJECT	FARM INCOME WITHOUT PROJECT
SCALERS:	0.74	1.00	1.00	1.00	1.00	0.80	1.00	1.00
1978	4589.	1857.	0.	415.	165.	0.	11030.	11030.
1979	3936.	1420.	0.	772.	166.	178.	12843.	11747.
1980	2816.	0.	1397.	124.	53.	327.	14418.	12446.
1981	0.	0.	0.	124.	0.	410.	15271.	13018.
1982	0.	0.	0.	124.	0.	410.	16035.	13615.
1983	0.	0.	0.	0.	0.	410.	16836.	14239.
1984	0.	0.	0.	0.	0.	410.	17678.	14579.
1985	0.	0.	0.	0.	0.	410.	18560.	15577.
1986	0.	0.	0.	0.	0.	410.	19190.	16063.
1987	0.	0.	0.	0.	0.	410.	19827.	16559.
1988	0.	0.	0.	0.	0.	410.	20516.	17087.
1989	0.	0.	0.	0.	0.	410.	21209.	17622.
1990	0.	0.	0.	0.	0.	410.	21648.	17996.
1991	0.	0.	0.	0.	0.	410.	22302.	18462.
1992	0.	0.	0.	0.	0.	410.	22681.	18752.
1993	0.	0.	0.	0.	0.	410.	23066.	19047.
1994	0.	0.	0.	0.	0.	410.	23460.	19347.
1995	0.	0.	0.	0.	0.	410.	23859.	19652.
1996	0.	0.	0.	0.	0.	410.	23859.	19652.
1997	0.	0.	0.	0.	0.	410.	23859.	19652.
1998	0.	0.	0.	0.	0.	410.	23859.	19652.
1999	0.	0.	0.	0.	0.	410.	23859.	19652.
2000	0.	0.	0.	0.	0.	410.	23859.	19652.
2001	0.	0.	0.	0.	0.	410.	23859.	19652.
2002	0.	0.	0.	0.	0.	410.	23859.	19652.
2003	0.	0.	0.	0.	0.	410.	23859.	19652.
2004	0.	0.	0.	0.	0.	410.	23859.	19652.
2005	-3926.	-1101.	-524.	0.	0.	410.	23859.	19652.

*Investment component 1 is estimated at 74 percent of that described in the "base case"; (Table 11.18) maintenance costs are estimated at 80 percent of that described in the "base case". These adjustments are indicative of changes in project costs if the NIA is already constructing ₱ 4,000,000 of farm roads which are included in the project.

Table 11.23

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

INTERNAL RETURN ON TOTAL CAPITAL 14.592 PERCENT

PERIOD		INVESTMENT (PESO1000)			OPERATING (PESO1000)			PRESENT VALUE FACTOR	PRESENT VALUE	
NO.	YEAR	FACILITIES	WORKING CAPITAL	TOTAL	TOTAL REVENUE	OPERATING EXPENSES	NET REVENUE		TOTAL INVESTMENT	NET REVENUE
1	1978	7026.	0.	7026.	11030.	11030.	0.	1.0000	7026.	0.
2	1979	6294.	178.	6472.	12843.	11747.	1096.	0.8727	5648.	956.
3	1980	4390.	327.	4717.	14418.	12446.	1972.	0.7615	3592.	1502.
4	1981	124.	410.	534.	15271.	13018.	2253.	0.6646	355.	1497.
5	1982	24.	410.	534.	16035.	13615.	2420.	0.5799	310.	1403.
6	1983	0.	410.	410.	16336.	14239.	2597.	0.5061	208.	1314.
7	1984	0.	410.	410.	17678.	14579.	3099.	0.4416	181.	1369.
8	1985	0.	410.	410.	18560.	15577.	2983.	0.3854	158.	1150.
9	1986	0.	410.	410.	19190.	16063.	3127.	0.3363	138.	1052.
10	1987	0.	410.	410.	19827.	16558.	3269.	0.2935	120.	959.
11	1988	0.	410.	410.	20516.	17087.	3429.	0.2561	105.	878.
12	1989	0.	410.	410.	21209.	17622.	3587.	0.2235	92.	802.
13	1990	0.	410.	410.	21648.	17996.	3652.	0.1951	80.	712.
14	1991	0.	410.	410.	22302.	18462.	3840.	0.1702	70.	654.
15	1992	0.	410.	410.	22681.	18752.	3929.	0.1485	61.	584.
16	1993	0.	410.	410.	23066.	19047.	4019.	0.1296	53.	521.
17	1994	0.	410.	410.	23460.	19347.	4113.	0.1131	46.	465.
18	1995	0.	410.	410.	23859.	19652.	4207.	0.0987	41.	415.
19	1996	0.	410.	410.	23859.	19652.	4207.	0.0861	35.	362.
20	1997	0.	410.	410.	23859.	19652.	4207.	0.0752	31.	316.
21	1998	0.	410.	410.	23859.	19652.	4207.	0.0656	27.	276.
22	1999	0.	410.	410.	23859.	19652.	4207.	0.0572	23.	241.
23	2000	0.	410.	410.	23859.	19652.	4207.	0.0500	21.	210.
24	2001	0.	410.	410.	23859.	19652.	4207.	0.0436	18.	183.
25	2002	0.	410.	410.	23859.	19652.	4207.	0.0380	16.	160.
26	2003	0.	410.	410.	23859.	19652.	4207.	0.0332	14.	140.
27	2004	0.	410.	410.	23859.	19652.	4207.	0.0290	12.	122.
28	2005	-5551.	410.	-5140.	23859.	19652.	4207.	0.0253	-130.	106.
TOTAL		12408.	10765.	23172.	579019.	483357.	95662.		18351.	18351.

INTEREST PER CENT	BENEFIT/COST RATIO
10.000	1.395
11.000	1.289
12.000	1.196
13.000	1.113
14.000	1.040
15.000	0.974

PRESENT VALUE IN PESO1000		
REVENUE	OUTLAY	BALANCE
27403.	19641.	7762.
24920.	19331.	5589.
22764.	19038.	3726.
20882.	18761.	2121.
19233.	18499.	734.
17780.	18252.	-472.

ALTERNATIVES:

Investment costs component 1 are 74 percent of "base case" (Table 11.18) maintenance costs are 80 percent of "base case".

Table 11.24

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

YEAR	INVESTMENT COMPONENT 1	INVESTMENT COMPONENT 2	INVESTMENT COMPONENT 3	INVESTMENT COMPONENT 4	INVESTMENT COMPONENT 5	MAINTENANCE	FARM INCOME WITH PROJECT	FARM INCOME WITHOUT PROJECT
SCALERS:	0.60	1.00	1.00	1.00	1.00	0.72	1.00	1.00
1978	3721.	1857.	0.	415.	165.	0.	11030.	11030.
1979	3191.	1420.	0.	772.	166.	160.	12843.	11747.
1980	2283.	0.	1397.	124.	53.	294.	14418.	12446.
1981	0.	0.	0.	124.	0.	369.	15271.	13018.
1982	0.	0.	0.	124.	0.	369.	16035.	13615.
1983	0.	0.	0.	0.	0.	369.	16836.	14239.
1984	0.	0.	0.	0.	0.	369.	17678.	14579.
1985	0.	0.	0.	0.	0.	369.	18560.	15577.
1986	0.	0.	0.	0.	0.	369.	19190.	16063.
1987	0.	0.	0.	0.	0.	369.	19827.	16558.
1988	0.	0.	0.	0.	0.	369.	20516.	17087.
1989	0.	0.	0.	0.	0.	369.	21209.	17622.
1990	0.	0.	0.	0.	0.	369.	21648.	17996.
1991	0.	0.	0.	0.	0.	369.	22302.	18462.
1992	0.	0.	0.	0.	0.	369.	22681.	18752.
1993	0.	0.	0.	0.	0.	369.	23066.	19047.
1994	0.	0.	0.	0.	0.	369.	23460.	19347.
1995	0.	0.	0.	0.	0.	369.	23859.	19652.
1996	0.	0.	0.	0.	0.	369.	23859.	19652.
1997	0.	0.	0.	0.	0.	369.	23859.	19652.
1998	0.	0.	0.	0.	0.	369.	23859.	19652.
1999	0.	0.	0.	0.	0.	369.	23859.	19652.
2000	0.	0.	0.	0.	0.	369.	23859.	19652.
2001	0.	0.	0.	0.	0.	369.	23859.	19652.
2002	0.	0.	0.	0.	0.	369.	23859.	19652.
2003	0.	0.	0.	0.	0.	369.	23859.	19652.
2004	0.	0.	0.	0.	0.	369.	23859.	19652.
2005	-3183.	-1101.	-524.	0.	0.	369.	23859.	19652.

*Investment component 1 is estimated at 60 persent of that described in the "base case" (Table 11.18); maintenace costs are estimated at 72 percent of that described in the "base case". These adjustments are indicative of changes in project costs if 50 percent of the proposed farm ditch network already exists and if the NIA has or shortly will construct ₱ 4,000,000 of farm roads which are currently included in the project.

Table 11.25

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

INTERNAL RETURN ON TOTAL CAPITAL 16.617 PERCENT

PERIOD NO.	PERIOD YEAR	INVESTMENT (PESO1000) FACILITIES	INVESTMENT (PESO1000) WORKING CAPITAL	INVESTMENT (PESO1000) TOTAL	OPERATING (PESO1000) TOTAL REVENUE	OPERATING (PESO1000) OPERATING EXPENSES	OPERATING (PESO1000) NET REVENUE	PRESENT VALUE FACTOR	PRESENT VALUE TOTAL INVESTMENT	PRESENT VALUE NET REVENUE
1	1978	6158.	0.	6158.	11030.	11030.	0.	1.0000	6158.	0.
2	1979	5549.	160.	5709.	12843.	11747.	1096.	0.8575	4896.	940.
3	1980	3857.	294.	4151.	14418.	12446.	1972.	0.7353	3053.	1450.
4	1981	124.	369.	493.	15271.	13018.	2253.	0.6305	311.	1421.
5	1982	24.	369.	493.	16035.	13615.	2420.	0.5407	267.	1308.
6	1983	0.	369.	369.	16836.	14239.	2597.	0.4636	171.	1204.
7	1984	0.	369.	369.	17678.	14579.	3099.	0.3976	147.	1232.
8	1985	0.	369.	369.	18560.	15577.	2983.	0.3409	126.	1017.
9	1986	0.	369.	369.	19190.	16063.	3127.	0.2923	108.	914.
10	1987	0.	369.	369.	19827.	16558.	3269.	0.2507	93.	819.
11	1988	0.	369.	369.	20516.	17087.	3429.	0.2150	79.	737.
12	1989	0.	369.	369.	21209.	17622.	3587.	0.1843	68.	661.
13	1990	0.	369.	369.	21648.	17996.	3652.	0.1581	58.	577.
14	1991	0.	369.	369.	22302.	18462.	3840.	0.1355	50.	520.
15	1992	0.	369.	369.	22681.	18752.	3929.	0.1162	43.	457.
16	1993	0.	369.	369.	23066.	19047.	4019.	0.0997	37.	401.
17	1994	0.	369.	369.	23460.	19347.	4113.	0.0855	32.	352.
18	1995	0.	369.	369.	23859.	19652.	4207.	0.0733	27.	308.
19	1996	0.	369.	369.	23859.	19652.	4207.	0.0628	23.	264.
20	1997	0.	369.	369.	23859.	19652.	4207.	0.0539	20.	227.
21	1998	0.	369.	369.	23859.	19652.	4207.	0.0462	17.	194.
22	1999	0.	369.	369.	23859.	19652.	4207.	0.0396	15.	167.
23	2000	0.	369.	369.	23859.	19652.	4207.	0.0340	13.	143.
24	2001	0.	369.	369.	23859.	19652.	4207.	0.0291	11.	123.
25	2002	0.	369.	369.	23859.	19652.	4207.	0.0250	9.	105.
26	2003	0.	369.	369.	23859.	19652.	4207.	0.0214	8.	90.
27	2004	0.	369.	369.	23859.	19652.	4207.	0.0184	7.	77.
28	2005	-4808.	369.	-4439.	23859.	19652.	4207.	0.0158	-70.	66.
	TOTAL	11005.	9688.	20693.	579019.	483357.	95662.		15775.	15775.

INTEREST PER CENT	BENEFIT/COST RATIO	PRESENT VALUE IN PESO1000 REVENUE	PRESENT VALUE IN PESO1000 OUTLAY	PRESENT VALUE IN PESO1000 BALANCE
10.000	1.578	27403.	17361.	10042.
11.000	1.459	24920.	17081.	7839.
12.000	1.354	22764.	16816.	5947.
13.000	1.260	20882.	16567.	4315.
14.000	1.178	19233.	16331.	2901.
15.000	1.104	17780.	16109.	1671.

ALTERNATIVE:

Investment costs component 1 are 60 percent of "base case" (Table 11.18) maintenance costs are 72 percent of "base case".

Table 11.26

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

YEAR	INVESTMENT COMPONENT 1	INVESTMENT COMPONENT 2	INVESTMENT COMPONENT 3	INVESTMENT COMPONENT 4	INVESTMENT COMPONENT 5	MAINTENANCE	FARM INCOME WITH PROJECT	FARM INCOME WITHOUT PROJECT
SCALERS:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95
1978	6202.	1857.	0.	415.	165.	0.	11030.	10478.
1979	5319.	1420.	0.	772.	166.	222.	12843.	11160.
1980	3805.	0.	1397.	124.	53.	409.	14418.	11824.
1981	0.	0.	0.	124.	0.	513.	15271.	12367.
1982	0.	0.	0.	124.	0.	513.	16035.	12934.
1983	0.	0.	0.	0.	0.	513.	16836.	13527.
1984	0.	0.	0.	0.	0.	513.	17678.	13859.
1985	0.	0.	0.	0.	0.	513.	18560.	14798.
1986	0.	0.	0.	0.	0.	513.	19190.	15260.
1987	0.	0.	0.	0.	0.	513.	19827.	15730.
1988	0.	0.	0.	0.	0.	513.	20516.	16233.
1989	0.	0.	0.	0.	0.	513.	21209.	16741.
1990	0.	0.	0.	0.	0.	513.	21648.	17096.
1991	0.	0.	0.	0.	0.	513.	22302.	17539.
1992	0.	0.	0.	0.	0.	513.	22681.	17814.
1993	0.	0.	0.	0.	0.	513.	23066.	18095.
1994	0.	0.	0.	0.	0.	513.	23460.	18380.
1995	0.	0.	0.	0.	0.	513.	23859.	18669.
1996	0.	0.	0.	0.	0.	513.	23859.	18669.
1997	0.	0.	0.	0.	0.	513.	23859.	18669.
1998	0.	0.	0.	0.	0.	513.	23859.	18669.
1999	0.	0.	0.	0.	0.	513.	23859.	18669.
2000	0.	0.	0.	0.	0.	513.	23859.	18669.
2001	0.	0.	0.	0.	0.	513.	23859.	18669.
2002	0.	0.	0.	0.	0.	513.	23859.	18669.
2003	0.	0.	0.	0.	0.	513.	23859.	18669.
2004	0.	0.	0.	0.	0.	513.	23859.	18669.
2005	-5305.	-1101.	-524.	0.	0.	513.	23859.	18669.

*Annual farm income without project estimated at 95 percent of that described in the "base case" (Table 11.18). This adjustment is indicative of changes in project benefits if a portion of the area in the BRIS which is considered "irrigated" is determined to more closely approximate "rainfed" land.

Table 11.27

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

INTERNAL RETURN ON TOTAL CAPITAL 15.612 PERCENT

PERIOD		INVESTMENT (PESO1000)			OPERATING (PESO1000)			PRESENT VALUE FACTOR	PRESENT VALUE	
NO.	YEAR	ACILITIES	WORKING CAPITAL	TOTAL	TOTAL REVENUE	OPERATING EXPENSES	NET REVENUE		TOTAL INVESTMENT	NET REVENUE
1	1978	8639.	0.	8639.	11030.	10478.	552.	1.0000	8639.	552.
2	1979	7677.	222.	7899.	12843.	11160.	1683.	0.8650	6832.	1456.
3	1980	5379.	409.	5788.	14418.	11824.	2594.	0.7482	330.	1941.
4	1981	124.	513.	637.	15271.	12367.	2904.	0.6471	412.	1879.
5	1982	124.	513.	637.	16035.	12934.	3101.	0.5597	357.	1736.
6	1983	0.	513.	513.	16836.	13527.	3309.	0.4842	248.	1602.
7	1984	0.	513.	513.	17678.	13850.	3828.	0.4188	215.	1603.
8	1985	0.	513.	513.	18560.	14798.	3762.	0.3622	186.	1363.
9	1986	0.	513.	513.	19190.	15260.	3930.	0.3133	161.	1231.
10	1987	0.	513.	513.	19827.	15730.	4097.	0.2710	139.	1110.
11	1988	0.	513.	513.	20516.	16233.	4283.	0.2344	120.	1004.
12	1989	0.	513.	513.	21209.	16741.	4468.	0.2028	104.	906.
13	1990	0.	513.	513.	21648.	17096.	4552.	0.1754	90.	798.
14	1991	0.	513.	513.	22302.	17539.	4763.	0.1517	78.	723.
15	1992	0.	513.	513.	22681.	17814.	4867.	0.1312	67.	639.
16	1993	0.	513.	513.	23066.	18095.	4971.	0.1135	58.	564.
17	1994	0.	513.	513.	23460.	18380.	5080.	0.0982	50.	499.
18	1995	0.	513.	513.	23859.	18669.	5190.	0.0849	44.	441.
19	1996	0.	513.	513.	23859.	18669.	5190.	0.0734	38.	381.
20	1997	0.	513.	513.	23859.	18669.	5190.	0.0635	33.	330.
21	1998	0.	513.	513.	23859.	18669.	5190.	0.0549	28.	285.
22	1999	0.	513.	513.	23859.	18669.	5190.	0.0475	24.	247.
23	2000	0.	513.	513.	23859.	18669.	5190.	0.0411	21.	213.
24	2001	0.	513.	513.	23859.	18669.	5190.	0.0356	18.	185.
25	2002	0.	513.	513.	23859.	18669.	5190.	0.0308	16.	160.
26	2003	0.	513.	513.	23859.	18669.	5190.	0.0266	14.	138.
27	2004	0.	513.	513.	23859.	18669.	5190.	0.0230	12.	119.
28	2005	-6930.	513.	-6417.	23859.	18669.	5190.	0.0199	-128.	103.
	TOTAL	15013.	13456.	28469.	579019.	459189.	119830.		22206.	22206.

INTEREST PER CENT	BENEFIT/COST RATIO
10.000	1.461
11.000	1.354
12.000	1.260
13.000	1.177
14.000	1.103
15.000	1.037

PRESENT VALUE IN PESO1000

REVENUE	OUTLAY	BALANCE
35203.	24101.	11102.
32112.	23718.	8394.
29426.	23355.	6071.
27081.	23013.	4068.
25024.	22690.	2334.
23211.	22385.	826.

ALTERNATIVE:

Farm income without project is estimated at 95 percent of "base case" (Table 11.18).

Table 11.28

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

YEAR	INVESTMENT COMPONENT 1	INVESTMENT COMPONENT 2	INVESTMENT COMPONENT 3	INVESTMENT COMPONENT 4	INVESTMENT COMPONENT 5	MAINTENANCE	FARM INCOME WITH PROJECT	FARM INCOME WITHOUT PROJECT
SCALERS:	0.60	1.00	1.00	1.00	1.00	0.72	1.00	0.95
1978	3721.	1857.	0.	415.	165.	0.	11030.	10478.
1979	3191.	1420.	0.	772.	166.	160.	12843.	11160.
1980	2283.	0.	1397.	124.	53.	294.	14418.	11824.
1981	0.	0.	0.	124.	0.	369.	15271.	12367.
1982	0.	0.	0.	124.	0.	369.	16035.	12934.
1983	0.	0.	0.	0.	0.	369.	16836.	13527.
1984	0.	0.	0.	0.	0.	369.	17678.	13850.
1985	0.	0.	0.	0.	0.	369.	18560.	14798.
1986	0.	0.	0.	0.	0.	369.	19190.	15260.
1987	0.	0.	0.	0.	0.	369.	19827.	15730.
1988	0.	0.	0.	0.	0.	369.	20516.	16233.
1989	0.	0.	0.	0.	0.	369.	21209.	16741.
1990	0.	0.	0.	0.	0.	369.	21648.	17096.
1991	0.	0.	0.	0.	0.	369.	22302.	17539.
1992	0.	0.	0.	0.	0.	369.	22681.	17814.
1993	0.	0.	0.	0.	0.	369.	23066.	18095.
1994	0.	0.	0.	0.	0.	369.	23460.	18380.
1995	0.	0.	0.	0.	0.	369.	23859.	18669.
1996	0.	0.	0.	0.	0.	369.	23859.	18569.
1997	0.	0.	0.	0.	0.	369.	23859.	18669.
1998	0.	0.	0.	0.	0.	369.	23959.	18669.
1999	0.	0.	0.	0.	0.	369.	23859.	18659.
2000	0.	0.	0.	0.	0.	369.	23859.	18669.
2001	0.	0.	0.	0.	0.	369.	23859.	18669.
2002	0.	0.	0.	0.	0.	369.	23859.	18569.
2003	0.	0.	0.	0.	0.	369.	23859.	18669.
2004	0.	0.	0.	0.	0.	369.	23859.	18669.
2005	-3183.	-1101.	-524.	0.	0.	369.	23859.	18669.

*Investment component 1 is estimated at 60 percent of that described in the "base case" (Table 11.18); maintenance costs are estimated at 72 percent of that described in the "base case"; annual farm income without project is estimated at 95 percent of that described in the "base case". These adjustments are indicative of changes in project costs and benefits if 50 percent of the farm ditch network already exists, if the NIA has or shortly will construct ₱4,000,000 of farm roads which are included in the project, and if a portion of the land in the BRIS which is considered to be irrigated is actually rainfed.

Table 11.29

NET RETURNS TO IRRIGATION AND DRAINAGE IMPROVEMENTS TO BARIT RIVER IRRIGATION SYSTEM

INTERNAL RETURN ON TOTAL CAPITAL 22.200 PERCENT

PERIOD		INVESTMENT (PESO1000)			OPERATING (PESO1000)			PRESENT VALUE FACTOR	PRESENT VALUE	
NO.	YEAR	FACILITIES	WORKING CAPITAL	TOTAL	TOTAL REVENUE	OPERATING EXPENSES	NET REVENUE		TOTAL INVESTMENT	NET REVENUE
1	1978	6158.	0.	6158.	11030.	10478.	552.	1.0000	6158.	552.
2	1979	5549.	160.	5709.	12843.	11160.	1683.	0.8183	4672.	1378.
3	1980	3857.	294.	4151.	14418.	11824.	2594.	0.6697	2780.	1737.
4	1981	124.	369.	493.	15271.	12367.	2904.	0.5480	270.	1591.
5	1982	124.	369.	493.	16035.	12934.	3101.	0.4485	221.	1391.
6	1983	0.	369.	369.	16836.	13527.	3309.	0.3670	136.	1214.
7	1984	0.	369.	369.	17678.	13850.	3828.	0.3003	111.	1150.
8	1985	0.	369.	369.	18560.	14798.	3762.	0.2458	91.	925.
9	1986	0.	369.	369.	19190.	15260.	3930.	0.2011	74.	790.
10	1987	0.	369.	369.	19827.	15730.	4097.	0.1646	61.	674.
11	1988	0.	369.	369.	20516.	16233.	4283.	0.1347	50.	577.
12	1989	0.	369.	369.	21209.	16741.	4468.	0.1102	41.	492.
13	1990	0.	369.	369.	21648.	17096.	4552.	0.0902	33.	411.
14	1991	0.	369.	369.	22302.	17539.	4763.	0.0738	27.	352.
15	1992	0.	369.	369.	22681.	17814.	4867.	0.0604	22.	294.
16	1993	0.	369.	369.	23066.	18095.	4971.	0.0494	18.	246.
17	1994	0.	369.	369.	23460.	18380.	5080.	0.0404	15.	205.
18	1995	0.	369.	369.	23859.	18669.	5190.	0.0331	12.	172.
19	1996	0.	369.	369.	23859.	18669.	5190.	0.0271	10.	141.
20	1997	0.	369.	369.	23859.	18669.	5190.	0.0222	8.	115.
21	1998	0.	369.	369.	23859.	18669.	5190.	0.0181	7.	94.
22	1999	0.	369.	369.	23859.	18669.	5190.	0.0148	5.	77.
23	2000	0.	369.	369.	23859.	18669.	5190.	0.0121	4.	63.
24	2001	0.	369.	369.	23859.	18669.	5190.	0.0099	4.	52.
25	2002	0.	369.	369.	23859.	18669.	5190.	0.0081	3.	42.
26	2003	0.	369.	369.	23859.	18669.	5190.	0.0067	2.	35.
27	2004	0.	369.	369.	23859.	18669.	5190.	0.0054	2.	28.
28	2005	-4808.	369.	-4439.	23859.	18669.	5190.	0.0045	-20.	23.
	TOTAL	11005.	9688.	20693.	579019.	459189.	119830.		14819.	14819.

INTEREST PER CENT	BENEFIT/COST RATIO
10.000	2.028
11.000	1.880
12.000	1.750
13.000	1.635
14.000	1.532
15.000	1.441

PRESENT VALUE IN PESO1000

REVENUE	OUTLAY	BALANCE
35203.	17361.	17841.
32112.	17081.	15031.
29426.	16816.	12610.
27081.	16567.	10514.
25024.	16331.	8693.
23211.	16109.	7102.

ALTERNATIVE:

Investment costs component 1 are 60 percent of "base case"(Table 11.18); maintenance costs are 72 percent of "base case"; farm income without project is 95 percent of "base case".